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Diagnosis and Treatment of Carcinoma of the Uterine Cervix
A Panel Discussion[1]

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Introduction

EDWIN C. ERNST, M.D.

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I HOPE THAT WE MAY have an interesting discussion and present without too many words the facts relating to cancer of the cervix, based on the observations of my confreres, who are experienced in certain special lines of radiation and surgical therapy. These gentlemen have assumed a grave responsibility, since they will be subject to attack by you and by the individual members of the panel.

First of all, I should like to introduce the various essayists: Dr. Arneson will discuss the clinical diagnosis of cancer of the cervix, and Dr. Siebert will discuss the pathology; Dr. Brewer will take up the surgical phases and Dr. Bowing the radium treatment; Dr. Waterman will present his experiences with interstitial radium therapy, and Dr. del Regato will speak on transvaginal roentgen irradiation. Last but not least, my friend, Dr. Jenkinson, is going to present some statistics which should throw further light upon this important subject.

These essayists will present their positions briefly, stating the salient points, following which each of them may address such questions as he desires to the others. Finally, the audience will have an opportunity for questions and discussion.

I am very happy to present to you Dr. Arneson of St. Louis.

[1] Presented at the Thirty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill. Dec. 1–6, 1946.

Clinical Diagnosis of Carcinoma of the Cervix

A. N. ARNESON, M.D.[1]

BIOPSY IS THE basis for diagnosis in cancer of the cervix. Histologic examination does not, however, present all the necessary criteria for establishing prognosis and selecting suitable methods of treatment. Prognosis depends largely upon the clinical stage which the cancer has reached. It is obvious, of course, that we cannot expect success in every favorable case, nor should we expect failure in all advanced lesions. There are other factors which affect the response to treatment.

A high degree of radiosensitivity does not imply a high degree of curability. In markedly sensitive lesions there may be rapid regression with prompt recurrence and a short span of life, while tumors slow to regress may sometimes permit survival for longer periods. Such variations in clinical behavior will be reflected in survival rates. One might expect a degree of correlation to be found between the microscopic appearance of tumors and their curability. There is, indeed, an established relationship between anaplasia and favorable degrees of radiosensitivity, but it is difficult to correlate histologic characteristics with clinical results.

We may, then, expect variation in response to treatment not accurately predictable upon the basis of the clinical stage of advance or the histologic appearance of the biopsy specimen. In some instances regression will be prompt and complete. In others resistance to radiation will be equal to or greater than that of the adjacent normal tissues. Some patients will show a slow but incomplete regression, with persistent cancer that remains clinically inactive for long periods. Such differences in clinical behavior must be due to variations in the biologic properties of tumor growth.

Further evidence of differences in biologic behavior can be found in comparing the gross characteristics of different tumors. There is no definite relationship, for example, between the size of the primary lesion and the stage of clinical advance. Large bulky tumors may be confined to the cervix itself; on the other hand, extensive infiltrations and even distant metastases can occur with but slight enlargement of the cervix. Neither is there any definite relationship between the duration of symptoms and the extent of involvement. Patients with early lesions may have had symptoms of cancer for relatively long periods, while others with more advanced tumors may have sought treatment immediately after the first suggestive sign. Variations in the size of the primary lesion and in duration of symptoms can be explained upon the basis of the infiltrating qualities of tumor growth. A tendency toward outward proliferation or toward deeper infiltration forms a basis for classification into different biologic types. In the attempt to classify lesions into everting and infiltrating types, however, we come immediately upon the problem of disposing of a third form, which shows a crater and is not easily fitted into one of the basic varieties. The cratered forms present, in addition, the factor of infection, which is always present to a considerable degree due to their extensive ulceration. The presence of severe infection has a definitely unfavorable effect upon tumor regression.

(1) *Everting types* produce a cauliflower-like growth that begins as a small raised lesion which can grow rapidly to a size that practically fills the vagina. They vary in their infiltrating qualities, but even the larger forms may present clinical evidence that the disease is limited to the cervix itself. Because of a minimum of

[1] From The Edward Mallinckrodt Institute of Radiology and the Department of Obstetrics and Gynecology, Washington University School of Medicine, and the Barnard Free Skin and Cancer Hospital, St. Louis, Mo.

connective tissue they are soft and friable. They bleed easily and profusely, due not only to their friability but also to their copious blood supply. For these reasons, bleeding and a thin watery discharge tend to appear early in the disease. Everting cancers present a favorable prognosis. They are, as a rule, radiosensitive and, because of their early symptomatology, are usually diagnosed in a favorable stage of clinical advance.

(2) *Infiltrating types* produce diffuse enlargement of the cervix, which usually proceeds slowly despite the fact that deeper tissues are invaded. The cervix becomes hard and nodular and may become indistinguishable, with obliteration of the vaginal fornices. The tumor frequently grows beneath an intact mucous membrane. Ulcerations are few in number and tend to occur late in the disease. Bleeding is not an early symptom but may be preceded for a fairly long period by a thin watery discharge. Infiltrating types are characterized by a maximum of fibroblastic activity and a scant blood supply. A possible explanation of these qualities can be made on the basis of an attempt on the part of the normal tissues of the host to resist invasion by throwing up a barrier of connective tissue, with an associated decrease in vascularity. In this group prognosis is poor, due to resistance to radiation and to the fact that the disease has usually advanced to an unfavorable stage by the time diagnosis is established.

(3) *Cratered lesions* may be assumed to have begun as one or the other of the above types. Formation of a crater is due to loss of tissue from slough following necrosis. Death of tissue can occur spontaneously in tumors inadequately supplied with blood but is more often the result of infection. There is greater risk of severe infection in the everting types, due to their friability with frequent ulceration. Further evidence of the association between cratered forms and everting types can often be observed in the rather favorable degree of radiosensitivity of the latter despite the infection usually present.

To classify cancers of the cervix into different groups according to the gross characteristics of the lesion is of more than theoretical importance. Prognosis can be established more accurately if biologic qualities are considered in conjunction with stage of clinical advance and histologic appearance of the biopsy specimen, and an estimation of prognosis is of value in selecting suitable methods of treatment. The selection should be more effective, however, if made upon the basis of tumor response to be expected. This is not intended to imply that lesser amounts of radiation can be employed in the more radiosensitive lesions. It does hold that a given quantity of radiation will produce greater biologic change in certain tumors.

For a panel discussion of this kind, certain points seem worthy of mention in the discussion of clinical diagnosis. Among the everting lesions the prospects are favorable for rapid and complete regression. In such cases radiation given at a relatively high intensity may be tolerated fairly well by normal tissues of the tumor bed and produce favorable results. Treatment at lower intensities is, however, a more practical procedure. Infiltrative tumors will be more radioresistant. Regression will proceed slowly, and the fibrosis and ischemia already present in the tumor bed may result in untoward damage to its structures. Destruction of the tumor bed by radiation can permit unrestrained growth of cancer, due to removal of all the normal inhibitory mechanisms. In the treatment of infiltrating types, therefore, a low intensity of irradiation is essential. If the course of roentgen therapy is protracted or the radium dosage is divided among several applications, the total time of irradiation can be extended for administering greater total doses over the longer period of slow regression. The use of intravaginal x-ray therapy may prove to be of greater value in this group than in the everting types.

Cratered forms present a special problem due to the high degree of infection usually present. This may result in increased

radioresistance. The action of radiation is essentially traumatic. Infection also produces tissue trauma. In an infected environment, the tumor cells may develop resistance to certain forms of trauma. Infection also lowers the threshold to necrosis. An amount of radiation believed practical for a clean lesion may, in the presence of infection, result in an extensive breakdown of tissue. The problem is, therefore, similar to that found in the infiltrating type of cervical cancer. A plan of low-intensity irradiation protracted over a long period is more effective than large doses applied over a shorter time. Since many cratered forms are derived from everting lesions, however, the degree of radiosensitivity may be improved with decrease in infection.

Finally, mention should be made of the value of the classification here discussed in relation to the use of surgery in the treatment of cervical cancer. Among indications given for radical hysterectomy is the avoidance of persistent radiation ulcers and reappearance of cancer in the cervix itself. Risk of those sequelae is greatest in the infiltrating types. Due to delayed bleeding in such patients, however, the disease is often advanced beyond an operable stage by the time diagnosis is established. There may be evidence in the form of a thin watery discharge for long periods before bleeding occurs. That symptom is worthy of greater attention in programs of cancer control.

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Dr. Ernst: Thank you Dr. Arneson.

I am very happy to have Dr. Siebert with us. He is a pathologist and is particularly interested, as I know you are, in the diagnosis of early or questionable cancer. Following Dr. Siebert, Dr. Brewer, who is a clinician as well as a laboratory worker, will present the surgical aspects of cancer of the cervix.

Pathologic Aspects of Carcinoma of the Cervix Uteri

WALTER J. SIEBERT, M.D.
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CANCER OF THE uterus is the most frequent cancer in the female, and approximately 90 per cent of the cases are primary in the cervix, while only about 10 per cent are primary in the corpus.

The frequency of uterine cancer must be referred partly to the anatomical and physiological characteristics of the organ, more especially to its exposure to various forms of trauma and irritation. Endocrine factors and age probably also play a role. Multiple pregnancies with their attendant repeated lacerations disturb the normal structure and functions of the cervix, interfere with its nutrition, and expose it to chronic irritation and inflammation. A chronic cervicitis precedes cancer in approximately 75 per cent of cases. The routine examination of such tissue frequently reveals abnormalities in the morphology and position of the epithelium which constitute a precancerous condition.

Thus the prophylaxis of cancer of the cervix is a problem largely connected with prevention of lacerations and the proper post-partum care of the cervix, especially in women who have had multiple pregnancies and have reached their fortieth year. Periodic examinations, preferably with adequate biopsy material rather than vaginal smears, are to be emphasized.

Another important group of women who develop cancer of the cervix are those who have had a supravaginal hysterectomy, since an average of 1 to 3 per cent of supravaginal hysterectomies, without removal of the cervix, are followed by cancer. It is my opinion, based on these figures, that panhysterectomy is justified in all cases where hysterectomy is indicated.

The prognosis of cancer of the cervix depends upon its early recognition and the histologic grade of the neoplasm. Shields, Warren and others have classified tumors of the cervix according to their origin from the various layers of the normal squamous covering of the vaginal portion of the uterus. Tumors arising from the upper portion they designate as spinal-cell carcinoma, those that arise from the transitional cells of the deeper layers as transitional-cell carcinoma, and those having their origin in the basal or germinal layer as the fat spindle-cell type. The tumors may be further divided according to Broders' classification, based on the degree of differentiation of the cells, into Grades I, II, III, and IV, in that order of malignancy.

According to Warren's studies, only about 4 per cent of the spinal-cell carcinomas were found to have metastasized to the lymph nodes; of the fat spindle-cell carcinomas, on the other hand, 87 per cent had lymph node metastases. Thus, though tumors of the latter group are more radiosensitive, they are more rapidly invasive and their prognosis is accordingly unfavorable.

In choosing an area from which to take a biopsy specimen, a Schiller test is useful. I prefer to be present when a biopsy is done in order that I may see from what part of the tumor the tissue is taken and be certain that it is adequate in amount. I insist, also, on personally supervising the imbedding of the tissue in order to make sure that the suspicious area noted clinically appears in the sections. In all cases where a suspicious lesion or one suggestive of early carcinoma is present, serial sections should be obtained, as single sections have often proved negative in cases in which serial sections of the same lesions revealed early carcinoma.

[EDITOR'S NOTE: This paper, as presented, was illustrated by a large number of lantern slides, showing the various clinical stages and histologic types of cervical carcinoma.]

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Carcinoma of the Cervix: Surgical Aspects

JOHN I. BREWER, M.D.
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I BELIEVE THAT WE should take a very sane view of the surgical treatment of carcinoma of the cervix. Fundamentally I am a surgeon, and fundamentally I like it. The time, however, has come when we can realize that a discussion such as this means simply that there is no wholly adequate treatment of cervical carcinoma. If there were, we would need no discussion.

Surgery was condemned in the past, and rightfully so. Primary mortality was high. Bonney's figure of 10 per cent over his lifetime (and he represents the master so far as certain operative procedures are concerned) are beyond the limits to which we could subscribe. With the advent of therapeutic agents—transfusion, penicillin, sulfa drugs, etc.—it could be expected that primary operative mortality would be reduced. Since we think that all forms of treatment have failed, fundamentally, to cure carcinoma, we are permitted, I believe, to search further for better methods. Further search reveals, however, that so far there is nothing in the way of new types of treatment to present, so it is feasible again to try surgery.

The present goal of the surgeons is earlier diagnosis of cervical cancer so that operation can be tried. If they do nothing other than to make it a conscious process of everyone to look for early carcinoma, their program may be called a success.

Surgical treatment of cancer of the cervix is limited to Stages I and II, and rightfully so, but to get cases in Stage I or II (League of Nations' classification) one must, of necessity, search for them, and those of us who want to treat them surgically and thus acquire statistics and make them available as rapidly as possible, must immediately begin a detailed search for early cases.

Dr. Siebert has seen some early cases, but not nearly so many as he should. Indeed, no pathologist has seen as many as he should. But that is not the fault of the pathologist. It is the fault of the clinician—the fault of us who do not take enough biopsies and do not search diligently enough for carcinoma.

Patients are now doing their part more adequately, as demonstrated by studies that have been made. While it was formerly eleven months from the onset of symptoms before the patient presented herself for treatment, that time has now been shortened to five months; but many patients, after they present themselves, do not get, immediately enough, surgical therapy or radiation therapy. The diagnosis is not made.

The reason we feel that surgery should be used on a limited number of patients is, first, that cures—or preferably five- or ten-year arrest of the disease—with radiation have not been adequate; second, that the primary operative mortality is now reduced. It should be no higher than 1.5 per cent in competent hands. Another point is that we, in our experience, have seen too many local recurrences of carcinoma in the cervix itself, or in the upper vaginal vault, following x-ray or radium therapy. Removal of the cervix by surgery obviates a recurrence there and, since we also remove the upper portion of the vagina, carcinoma cannot recur at that site. In addition, surgery removes the lymph nodes of the pelvis. These nodes may be involved by carcinoma. Just how many are thus involved is hard to discern, since most patients have had some irradiation prior to surgery. It has been shown that lymph node metastases may be present even in early or so-called early carcinoma of the cervix—*in situ* cancer, or Stage I of the League of Nations' classification. Since such metastases may be

already present at operation, I do not believe we can tell from the clinical aspect when a lesion is absolutely *in situ* or early.

I am glad that Dr. Siebert brought up the serial section procedure. This brings out another point in favor of surgery. If we are to make an early diagnosis, we must have tissue to examine. Surgery removes those tissues and gives them to us for examination. If those that are taken out are thoroughly and completely studied, our knowledge of carcinoma of the cervix may be increased. Therefore, those who do surgery should study the specimens.

Indications for surgery as recommended by Meigs and others are as follows: Surgery should be done only in Stage I or II (League of Nations' classification). Surgery should be used only as an adjunct to irradiation. Surgery should be limited to patients under fifty and in good physical condition, with no contraindication of any type to operation. Also, the patient must be thin (and this is most important). There must be no lower vaginal metastases. I would add here that under no conditions do I subscribe to removal by simple amputation of the cervix of any lesion which is either suspicious or definitely diagnosed as carcinoma. This is to be condemned. If the patient has a suspicious lesion, or an early intraepithelial carcinoma, there is but one surgical procedure to be used—a Wertheim or modified Wertheim operation, removing the complete uterus, the broad ligament tissues, and adnexa. With this method five-year cures can be anticipated—but only anticipated, since it will take another ten or fifteen years before figures can be accumulated.

The primary complication to surgery, as recorded recently, is the occurrence of fistulas. This complication must be accepted if we are going to do surgery. To operate, one must acquire technic and that takes time. In Meigs' first 50 cases the incidence of ureterovaginal fistula was 8 per cent, but in his next series there was none.

Those surgeons who are technically qualified, those surgeons who will pathologically study their material, and those surgeons who will have adequate follow-up in large numbers should make a study of this problem for us, so that in five, ten, fifteen, or twenty years we shall have a true evaluation of the use of surgery under new conditions in the treatment of carcinoma of the cervix. A general swing toward surgery for carcinoma of the cervix should not be made at this time.

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Dr. Ernst: Thank you Dr. Siebert and Dr. Brewer. We will now have the subject of intracavitary radium therapy presented by Dr. Bowing.

Intracavitary Radium Therapy for Carcinoma of the Uterine Cervix[1]

HARRY H. BOWING, M.D.

IN THE MAIN, intracavitary radium therapy may be defined as the application of radium to the surface of a lesion occurring in any hollow place or space. Not only is it the oldest form of radium therapy of carcinoma of the uterine cervix but it also is a conservative method. Many improvements and refinements have made it most effective. Our experience with this method at the Mayo Clinic covers a period of thirty years. During that time, the technic employed has been rather constant, which permits the widest possible interpretation of the variable factors inherent in the patient and the disease.

The history, bimanual palpation, inspection and sounding of the genital tract, especially in the predominating Stage III lesion, are essential for diagnosis and treatment. A general physical examination and the required laboratory tests, including removal of tissue from the primary lesion for microscopic study, are absolutely essential from the standpoint of good management. A knowledge of pathology and physiology will sharpen the interest of the therapeutic radiologist. As a rule, constant vigilance by the physician and patient will be an important element in obtaining a good immediate and late result.

The standard platinum tube containing 50 mg. of radium sulfate (element) is used; the walls of the tube are 1 mm. thick. The applicator may contain one or more tubes. When distance is employed, it is maintained with 2 mm. or 1 cm. of Para rubber. The following factors are approximate for treatment of the average Stage III lesion. The time of the application may vary from three to twenty-four hours; the dose, therefore, ranges from 300 to 2,400 milligram hours. The interval between applications is one to seven days. The total time consumed may be ten to twenty-one days. The treatment area is divided into zones, and the dose in milligram hours applied to each zone is as follows: to the vaginal zone 2,100, to the proximal cervical zone 1,400, to the distal cervical zone 1,400, and to the intrauterine zone 2,000 to 2,400.

The method requires hospitalization only for the day of the treatment. The time that the patient has to spend in the hospital is from eight to ten days. No general anesthetic is used. A dose of 1/6 grain (0.01 gm.) of morphine sulfate may be administered hypodermically before the treatment. Barbiturates are used sparingly. All other drugs are given by the physician on the medical hospital service. In the past few years, the field has been dusted with a sulfonamide drug at the same time that radium therapy is applied. All applications of radium are made with the patient in the knee-chest position. With gentle unilateral separation of the labia, air is admitted to the vagina, which permits a type of endoscopic examination. The endoscope consists of a Sims' speculum and a direct electric lamp with a suitable handle. The vagina becomes a distended hollow organ and permits: (*a*) visual and palpatory examination of the normal and pathologic tissues; (*b*) selection of the site for the removal of representative material for biopsy; (*c*) the location of anatomic landmarks; (*d*) the placement of the radium applicator; (*e*) the placement of gauze packing to hold the applicator in position and to obtain as much distance as possible between the applicator and the adjacent normal anatomic structures. As treatment proceeds, the gross changes occurring in the neoplastic tissue owing to the rays of radium are readily visualized and their distribution and intensity guide the radium

[1] From the Section on Therapeutic Radiology, Mayo Clinic, Rochester, Minn.

therapist in his treatment of the lesion. All procedures are carried out with a minimum of trauma.

In some cases, the cervical canal is eccentric to the main malignant tumor. In that event, the applicator is placed in the center of the malignant medullary mass. In cases in which the mass is very firm, a slight stab wound may have to be made for the applicator.

As a rule, no anatomic difficulties are encountered in cases in which the lesions are classified as Stage I or II. The applications of radium may be carried out daily so long as no distressing systemic effects occur. However, lesions which are classified as Stage III or IV may distort the anatomic landmarks and make their identification tedious and in some cases impossible at the first treatment. A large medullary cervical mass or a large crater with necrotic walls is the chief offender in this regard; but as time passes, these features of the malignant process are resolved, the field is restored to a more normal state, and radium can be applied throughout the involved region. Distribution of the radium is an essential element in the intensive broken-dose method. Although the individual response to treatment will vary, it can, at least in a measure, be anticipated.

Judgment and skill are necessary for the greatest individualization of the intracavitary method of treatment. The response should be a rather slow one instead of a rapid change, which may result in necrosis and distressing complications, as a persistent discharge, foul odor, hemorrhage and fistulas. Judgment is essential in selecting and outlining the type of radium treatment at the time of the first consultation. The treatment should be designed for cure or palliation, though, to be sure, the total treatment time may furnish data that will alter the first estimation. In that event, the alteration should be fully discussed with the staff and, if accepted, should be charged against the judgment of the radium therapist. Provided all zones can be treated as outlined, the procedure is classified as a complete treatment (1) designed for cure; otherwise, it is classified as a limited treatment designed for palliation. On subsequent visits, the complete radium treatment should not be repeated; however, limited radium treatments may be applied to sites of active involvement in order to extend the period of palliation.

Supplemental Roentgen Therapy: Roentgen therapy is started a few days before radium therapy is completed. The pelvis is divided into two anterior and two posterior fields (2). The roentgen rays are generated at 200 kv.[2] and are filtered with approximately 0.75 mm. Cu and 1.0 mm. Al. A dose of 500 to 700 r is applied to each field. In selected cases, the doses are divided, and 250 to 350 r are administered daily. For very obese patients, additional filtration is used to obtain better penetration of the rays, but the dose per field is about the same as that employed in the average case. The doses are measured in air. In the average case in which the lesion is classified as Stage III, a second course of roentgen therapy is usually given after an interval of three months. We do not use larger doses of roentgen rays because they are likely to cause irritation of the bladder or intestine. The irritation of the intestine may cause bleeding from the mucous membrane and eventually may produce scarring and obstruction.

Roentgen therapy was employed alone in 41 of a series of 1,491 cases in which irradiation therapy was used in the years 1915–29, inclusive (1). In cases in which roentgen therapy is employed without radium therapy, the roentgenologic technic is the same as that which has been described, with the exception that the doses applied to each field may be increased to approximately 1,000 r.

RESULTS

The early response to treatment is most gratifying. The first response observed is the control of bleeding, which

[2] Prior to 1923, we used roentgen rays generated at 135 kv.

may occur in two or more days. The distressing unilateral aching in the back, hips, and legs may be relieved in four or five days. The discharge and odor of the lesion are the last features to respond to treatment.

The patients are instructed to return for examination every three or four months during the first year after irradiation treatment, every six or nine months during the second and third years, and every year thereafter.

The following analysis of the results of treatment is based on 1,491 cases in which this type of treatment was employed at the Clinic in the years 1915 to 1929, inclusive (3). As previously stated, in 41 of these cases roentgen therapy was the only type of treatment employed. Fifteen, or approximately 1 per cent of the patients died while they were in the hospital.

As the patients returned during the first year after their treatment, the late response was found to be equally gratifying. The uterine and adnexal infiltration was markedly reduced in extent. In some cases, the pelvic structures were free of any palpable characteristic infiltration due to residual malignant activity. As the years passed, statistical data were available to confirm our initial clinical impressions. During the first five years of our experience with this type of treatment, that is, in the years 1915 to 1919, inclusive (4) the treatment was used in 288 cases. Follow-up data were obtained in 264 of these. Of the 264 traced patients, 38, or 14.4 per cent were living three or more years after the completion of treatment. During the years 1920 to 1924, inclusive, the treatment was used in 556 cases, follow-up data being obtained in 522. Of the 522 traced patients, 185, or 35.4 per cent, were living three or more years after the completion of treatment. During the years 1925 to 1929, inclusive, the treatment was used in 647 cases. Follow-up data were obtained in 585 of these cases, and of the 585 traced patients, 250, or 42.7 per cent, were living three or more years after the completion of treatment. In several cases in each of these groups, the lesions had been modified by treatment before the patients came to the clinic.

This rather definite increase in the percentage of patients living three or more years after the completion of treatment was due to several factors, including (*a*) a satisfactory method of vaginal endoscopy to facilitate the placement of the applicator and gauze packing with minimal trauma; (*b*) the observation of the vaginal field during the initial days of therapy to guide the selection of the most effective treatment factors for each patient; (*c*) better distribution of the radium applicators in the vaginal and uterine fields of involvement; (*d*) the early recognition and treatment of potential and actual complications, such as bleeding and serious hemorrhage, localized inflammation, and necrosis of tissue.

In 1,079 of the 1,491 cases, the disease had not been modified by previous treatment. In these cases the lesions were classified as follows: Stage I, 13 cases; Stage II, 85 cases; Stage III, 825 cases; Stage IV, 156 cases. Follow-up data were obtained in all of the cases in which the lesion was classified as Stage I. Nine, or 69.2 per cent, of the 13 patients were living five or more years after the completion of treatment. Follow-up data were obtained in 78 of the 85 cases in which the lesion was classified as Stage II. Of the traced patients, 47, or 60.2 per cent, were living five or more years after the completion of treatment. Follow-up data were obtained in 753 of the 825 cases in which the lesion was classified as Stage III. Of the 753 patients, 224, or 29.7 per cent, were living five or more years after the completion of treatment. Follow-up data were obtained in 138 of the 156 cases in which the lesion was classified as Stage IV. Of the 138 traced patients, 9, or 6.5 per cent, were living five or more years after the completion of treatment.

The type of radium therapy employed has a definite effect on the prognosis. Of 565 traced patients who received a complete course of radium therapy, 299, or

52.9 per cent, lived three or more years after the completion of treatment; of 739 traced patients who received a limited course of radium therapy, only 158, or 21.4 per cent, lived for three or more years (3).

COMMENT

Evidently therapeutic radiologic judgment is an important element in prognosis, since it may possibly increase the chance of survival for three years or more. All supplemental efforts should be employed to further the possibility of applying a *complete* course of treatment. However, as a word of caution, we must not overtreat a very advanced lesion and in this way bring about distressing features to add to the difficulties of an already overburdened and apparently seriously ill patient. No data are available for an estimation of the morbidity rate in this series of cases. Morbidity occurred, however, but we were not impressed by the number and severity of the reactions.

Today the responsibility of the therapeutic radiologist in the treatment of carcinoma of the uterine cervix is great. The patient and her possible restoration to health should be his major concern. The outline of a plan of radiation treatment made at the initial consultation and designed for cure or palliation and to meet the therapeutic requirements of the patient will produce the best results.

The radium technic must be very flexible. For example, it must be adaptable to the therapeutic requirements of Stage I and Stage II lesions, notwithstanding the fact that they are few in number when compared with those of Stage III and Stage IV, as well as to the recurring and modified lesions and their usual distressing complications. The radiologist's comprehension and knowledge will guide him in the selection of the most effective treatment factors.

There is no substitute for patience and an allotted time in determining the most effective therapeutic strategy. Interest in the patient's recovery must extend through the initial period of treatment and the months and years that follow. With judicious, skillfully applied intracavitary radium therapy as the initial treatment, supplemented by roentgen therapy, it is possible to influence favorably the discharge, odor, pain, bleeding, and such potential distressing sequelae as fistulas, unilateral edema of the extremities, and hydronephrosis. In some cases, sound permanent healing of the primary lesion will occur in a minimal treatment time with a low mortality and morbidity rate. There should be no conflict between radium therapy and roentgen therapy; I contend they should be employed to complement each other; the greater the co-operation and co-ordination of effort the more effective will be the treatment.

There are few data in the therapeutic radiologist's field of endeavor that will furnish material for generalization; instead, the patient and the disease are both characteristically individual, as well as the response to treatment. However, in a measure, a certain pattern of satisfactory response will be observed, though this cannot be definitely predicted.

With an enlightened womanhood, an alert physician, and a skillful specialist guided by sound therapeutic judgment, the initial result should be prompt and the late result should be more permanent, or the period of palliation should be longer and more enduring.

SUMMARY

Briefly stated, the intracavitary, intensive broken-dose method of radium treatment, followed by supplemental roentgen therapy, furnishes a wide range of individualization for the greatest number of patients who have carcinoma of the uterine cervix. The treatments can be designed for cure or palliation. The immediate subjective and objective response occurs rather promptly. As time has passed, favorable statistical data have become available to support our initial interest and to encourage us to improve and refine

this conservative method of radium treatment for carcinoma of the uterine cervix.

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Dr. Ernst: Thank you Dr. Bowing.

The next presentation will be some pointed remarks along the line of interstitial radium therapy by Dr. Waterman, from Rhode Island.

Interstitial Radium Therapy in Carcinoma of the Cervix

GEORGE W. WATERMAN, M.D.

Providence, R. I.

RADIUM IN THE FORM of long element needles of low intensity, 2 to 3 mm. platinum filtration, with a long time interval, has been in use for the treatment of cervical carcinoma at the Rhode Island Hospital since 1926, a period of almost twenty-one years. Prior to 1926, small steel needles of 5 mg. content were used for this purpose. In 1926, on a visit to London, Dr. H. C. Pitts saw some use of these longer needles and brought home the idea. We undertook an experiment to see what could be done with interstitial radiation of this type, and we have had no reason to regret our decision. The great advantage lies in the fact that radium in this form can be placed out into the pelvic tissues, the zone where carcinoma is invading.

In our use of these needles, we have no idea at any time of pushing them out into empty space. We seek the edge of the growth, as we can feel it by way of the vagina and rectum, making a careful examination, under good light in the operating room, with the patient relaxed under an anesthetic. We then slip the needles into the advancing zone of growth.

The needles are element needles; they have the same intensity when we take them out as when we put them in. They are of small content, the radium is evenly distributed throughout their length, 0.66 mg. per c.c. of active length, and the filtration is such that only the gamma rays are effective. It is our belief that no other type of needle will exactly fit this purpose.

In addition to the parametrial needles, we have a platinum capsule of 20 mg. content that will deliver into the cervicouterine canal approximately 3,300 mg. hours over a period of seven days. All this radium is implanted and is left in place for the full time—168 hours. We think that protracted treatment of this type—small doses given over a long time interval—is a very important factor, both in causing the disappearance of the cancer cells and in preserving and perhaps fortifying the condition of the surrounding tissues.

The second great advantage that we find in this method of therapy is its extreme flexibility and adaptability to all types and conditions of cancer of the cervix. It does not make any difference whether the vagina is a short and narrow one, cone-shaped in the upper third, or whether it is a broad one, with a large cauliflower growth. The radium needles are easily inserted, perhaps with the finger in the rectum to guide them carefully into the uterosacral ligaments or into the part of the pelvis which is being invaded.

Another advantage is the non-necessity of using large sources of radium against the vaginal walls in order to obtain a relatively small amount of radiation in the deeper tissues, with consequent reduction in vaginal breakdown and slough. Also, the fact that only 50 or 60 mg. of radium is all is needed to treat a case represents some advantage to smaller institutions. The entire radium treatment is given in one dose.

The disadvantages of excessive incidence of sepsis, fistula formation, and intestinal injury, which have caused so many gynecologists and radiologists to fear interstitial radiation, have not been apparent in our experience. We have had our troubles with all these complications it is true, but not in excess of such complications reported by others using different methods.

With the use of deep x-ray therapy in infected cases, preliminary to radium, and with the sulfa drugs and penicillin, it would seem that fear of infection from interstitial sources is no longer a valid objection; in fact, we have had no immediate mor-

tality in 326 consecutive cases up to January 1946. In the Spring of 1946, we had one death from a pulmonary embolus on the second day after the radium was removed.

The results obtained, as measured by five-year survivals, have been excellent and have shown consistent improvement. In the last 198 cases the five-year survival rate (absolute) was 38.9 per cent; for 171 cases treated with radium, the figure (relative) was 44.4 per cent.

The needle we use is a long, delicate instrument, having a trocar point that is blunted. The radium is distributed evenly throughout the active length, and insertion can be done with practically no trauma. We do not fear the puncturing of large vessels or of the ureter. We do not feel that, if one of the needles came to lie across the ureter in any one spot, it would have any terrifically bad effect. In fact, our urinary complications have been slight, very few in number. If the point of the needle sticks out into the peritoneal cavity, we are not particularly worried. There is no radium in the point, and it is dull. It will do little harm. We are very careful and, by putting a finger in the rectum when inserting the needles posteriorly, we believe that we can largely avoid perforation of the peritoneum.

The method of applying the radium in a fairly early case may be described. With the finger in the vault, the needles are inserted almost under direct palpation and are distributed around the cervix. To insert the posterior needles, the finger is placed in the rectum and sterile drapes are placed over the perineum; the vagina is retracted by a Sims' speculum, the point of the needle is placed, and the needle is then directed into the uterosacral ligaments or toward the sides, or kept within the confines of the uterus posteriorly. A large gauze pack keeps the needles in place and serves to retract the vaginal walls.

[EDITOR'S NOTE: At this point a number of slides were presented, showing the method of introducing the radium needles and their distribution in the cervix The illustrations from which these slides were made appear in a paper by Waterman, Di Leone, and Tracy: Am. J. Roentgenol. **57:** 671, 1947.]

155 Thayer St.
Providence 6, R. I.

Dr. Ernst: Thank you Dr. Waterman.

We shall now continue with a discussion of roentgen therapy by the transvaginal method. Dr. del Regato.

Transvaginal Roentgen Therapy in Carcinoma of the Cervix[1]

J. A. DEL REGATO, M.D.
Columbia, Mo.

IN TALKING OF THE relative merits of transvaginal roentgen therapy in carcinoma of the uterine cervix, I would like to insist first upon the fact that whatever the means of internal treatment and the technic of its administration, whether this is intracavitary or interstitial radium therapy or transvaginal roentgen therapy, it constitutes only a complement of the external irradiation. In the majority of cases treated, the results will depend mostly upon the adequacy of the external irradiation, which logically should have preceded the internal phase of the treatment.

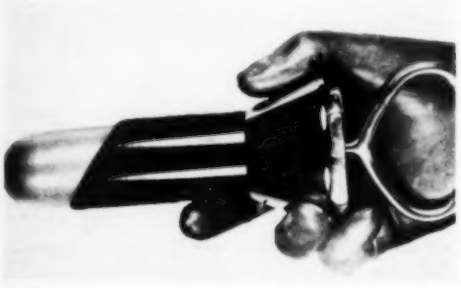

Fig. 1. Author's vaginal speculum, with a metal head, a transparent shaft, and a plunger to facilitate introduction.

Allen, Caldwell, Pusey, and many among the pioneers of radiation therapy tried transvaginal roentgen therapy. Their sporadic attempts never crystallized. The late Edwin A. Merritt is to be credited for having revived this form of treatment and for eloquently and forcibly pointing out its possibilities in the treatment of carcinoma of the cervix.

Merritt used the Ferguson bakelite specula after he had tried to use the walls of a urine specimen bottle as a speculum. Erskine devised an ingenious speculum made of expanding metal blades. This speculum is very applicable in early cases,

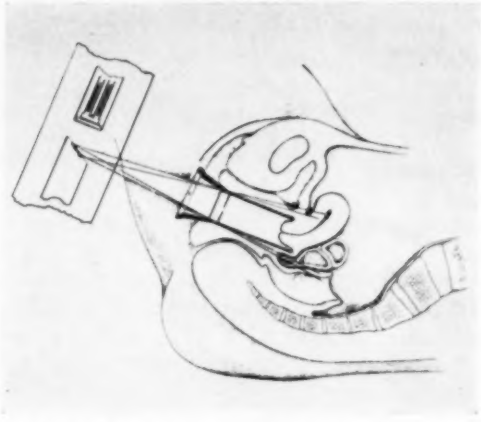

Fig. 2. Irradiation through a transparent-wall speculum allows the field to open to about 6 cm. in diameter at the level of the cervix.

but when the walls of the vagina are invaded, the use of an expanding speculum is not practicable. Wasson and other workers have preferred metal cylinders for the exclusive or even segmental irradiation of the cervix; this method may also be satisfactory in early cases, but I am convinced that it leads to serious inaccuracies. While collaborating with Merritt, I introduced a speculum composed of a metal head for the protection of the vulva and of a shaft transparent to radiations (Fig. 1). In its present form, this speculum allows a wide irradiation of the cervix, fornices, and adjacent parts of the parametria, while protecting, when required, the bladder and rectum (Fig. 2). In practice, a set of specula of several lengths and widths is necessary.

In our hospital we have now treated with transvaginal roentgen therapy following external irradiation, over 200 consecutive cases of carcinoma of the cervix of all stages. Not a patient has been refused treatment, none has received radium, and

[1] From the Department of Radiotherapy, The Ellis Fischel State Cancer Hospital, Columbia, Mo.

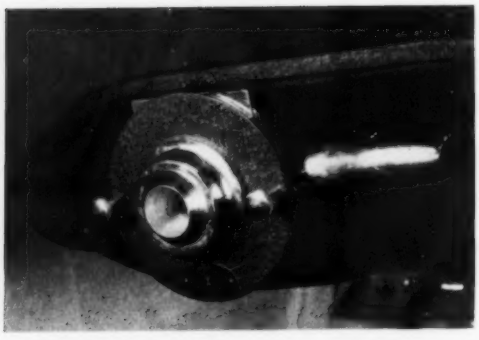

Fig. 3. A tube-head piece, fitting into the vaginal speculum, to maintain it in place during treatment.

very few have not completed treatment. Of 52 primary cases that applied for treatment in our hospital in 1943, only 2 failed to receive complete treatment. The patient is placed in the lithotomy position with the legs comfortably supported. The table is tilted to allow the intestine to fall out of the pelvis. The widest and longest speculum which can be introduced is used. The speculum head is adaptable to a corresponding part in the tube-head (Fig. 3.) We prefer radiations of moderate penetration, such as obtained from 140 to 150 kv. equipment, but also prefer to filter as heavily as possible, usually through 0.5 mm. of copper. The target-cervix distance is 25 cm. It is preferable to administer the treatment within two weeks, before the appearance of vaginal radioepithelitis. A very large total dose is not necessary when an adequate external irradiation has preceded. We administer a total of from 3,000 to 4,000 roentgens (measured in air at the level of the cervix) in from ten to twelve days.

Transvaginal roentgen therapy has secured a definite place in the treatment of carcinoma of the cervix. It has the advantage of completing the external irradiation without trauma to the healing tissues, without infectious complications, which so often hamper the practice of intracavitary curietherapy. Transvaginal roentgen therapy assures a more homogeneous irradiation of the cervix and adjacent structures; it requires no anesthesia or hospitalization; it can be sufficiently protracted to reduce to a minimum the untoward effects of irradiation. Even when the bladder or rectum is invaded, a vesicovaginal or rectovaginal fistula seldom occurs, due to the slow effect, which allows retraction of the tissues and vaginal atresia, thus avoiding the fistula formation, It is our impression that there is a lesser number of local recurrences when transvaginal roentgen therapy is used and that failures are mostly due to parametrial recurrences; these should be ascribed to the lack of penetration of our external irradiation.

I would have liked to quote five-year survival rates of my own, but I do not have these figures at present. I have just recapitulated the results in 52 consecutive, unselected patients with carcinoma of the cervix who applied for treatment to our hospital in the year 1943, having had no previous treatment. All but 2 patients received external roentgen therapy, followed by transvaginal roentgen therapy; no radium was used. The results now—after a minimum follow-up of three years—are as follows: 26 patients have died of cancer and 4 others have died of intercurrent diseases without evidence of recurrence; 22 patients are alive and without evidence of cancer, or a 42 per cent three-year survival. We need not emphasize that there is no pretense of comparing these figures with five-year control statistics.

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Columbia, Mo.

Dr. Ernst: Thank you Dr. del Regato.
We shall now conclude with some statistical remarks by Dr. Jenkinson.

Five-Year End-Results in the Treatment of Carcinoma of the Uterine Cervix

E. L. JENKINSON, M.D., E. L. PIRKEY, M.D., and F. J. HAMERNIK, M.D.
Chicago, Ill.

OUR PURPOSE is to outline the five-year end-results of an unselected series of 98 cases of squamous-cell carcinoma of the uterine cervix treated in the period 1935–41, inclusive. Mention will also be made of the various technics employed down to the present writing. Cases which were treated prior to 1935 are not included, as there is no accurate means of determining the precise dosage.

TABLE I: CASES TREATED
(*Period* 1935–41, *Inclusive*)

	Treated	Followed	Not Followed	Follow-up
Stage I	16	9	7	56.2%
Stage II	13	8	5	61.5%
Stage III	33	30	3	90.9%
Stage IV	36	28	8	80.0%
TOTAL	98	75	23	76.5%

TABLE II: RESULTS IN ALL STAGES

	Followed	Died of Cancer	Died of Other Causes	Five-Year Survival	Known Survival to Date	Not Followed Beyond Five Years
Stage I	9	2	..	7(77%)	5	2
Stage II	8	1	..	7(87.5%)	7	..
Stage III	30	25	..	8(26.6%)	5	..
Stage IV	28	27	..	1(3.5%)	1	..
TOTAL	75	55(73%)	..	23(30.6%)	18(24%)	2(3%)
Stages I and II	17	3	..	14(82.3%)	12(70.5%)	2(11.7%)

The 98 cases reported are unselected and comprise the usual cases seen in the radiological department of a civilian general hospital located in a large city. They represent all walks of life, being about equally divided between charity and private patients The follow-up is 76.5 per cent of all cases, that is, 75 cases were followed from the beginning of radiation therapy for at least five years or until death. It should be noted that the relatively low percentage of follow-up probably stems directly from the war-time social upheaval of the period 1941–46.

Schmitz' clinical classification was used throughout in order to correlate the extent of the disease when first seen with the result. Of the 75 patients followed, 55 or 73 per cent are known to be dead; 18 or 24 per cent are still alive; 23 or 30.6 per cent were alive and free of disease after at least five years. There are one ten-year cure, 2 nine-year cures, 2 eight-year cures, 4 seven-year cures, 5 six-year cures, and 9 five-year cures.

TABLE III: YEARS SURVIVAL

Years survival →	5	6	7	8	9	10	
Stage I	2	2	2	..	..	1	7
Stage II	3	1	..	1	2	..	7
Stage III	4	1	2	1	..	..	8
Stage IV	..	1	..	..	..	..	1
TOTALS	9	5	4	2	2	1	23

Among the 17 cases in Stages I and II there are 14 five-year survivals, or 82.3 per cent of those treated. There is a total salvage of 12 cases or 70.5 per cent definitely known to be alive at this writing.

The Stage III group of 30 cases shows 8 five-year survivals, or 26.6 per cent, and a total salvage of 5 cases or 16.6 per cent to date. The 28 cases in the Stage IV group produced one five-year survival, or 3.5 per cent, and 1 totally salvaged case to date,

TABLE IV: RESULTS WITH DIFFERENT FILTRATION

	200 kv.p. 0.5 mm. Cu 1.0 mm. Al	200 kv.p. 1.0 Cu 1.0 Al	200 kv.p. 0.45 Sn 0.25 Cu 1.0 Al	400 kv.p. 0.8 Sn 0.8 Pb 1.0 Fe	85 kv.p. Contact Phillips*	Total
Alive 5 years						
Stage I	2	..	5	..	1	7
Stage II	..	..	3	4	1	7
Stage III	..	..	6	2	1	8
Stage IV	..	..	..	1	..	1
Per cent alive at 5 years	11%	0%	41%	35%	100%	30.6%
Dead in 5 years						
Stage I	..	..	..	2	..	2
Stage II	1	..	..	..	..	1
Stage III	7	1	7	7	..	22
Stage IV	8	2	13	4	2	27
Per cent dead at 5 years	89%	100%	59%	65%	0%	69.4%

* Substituted for radium therapy.

or 3.5 per cent of the group. The average ages were as follows: for Stage I, 44.6 years; Stage II, 47.5 years; Stage III, 46.4 years, and Stage IV, 47 years.

The above figures do not vary too greatly from those recently reported in other clinics about the country, but we feel that it is worth while to point out one or two differences in our method of handling these cases as compared with a majority of the other institutions. The number of cases treated with the various technics are shown in Table IV, as well as the results obtained.

The majority of the cases were treated with the Thoræus filter (0.25 mm. Cu, 0.45 mm. Sn, and 1.0 mm. Al), at 200 kv.p., h.v.l. 1.9 mm. Cu, 20 r per minute (in air). When using this filter, we routinely administer 1,200 to 1,600 r (in air) to each field, with a minimum of untoward skin symptoms. We feel that this is important in the treatment of these patients.

Our first aim in the treatment of any patient is the complete eradication of the disease process, but there are certain other aspects that must be considered. Ranking second to complete cure is the ability to keep the patient comfortable both during the course of therapy and afterward.

Even in the apparently hopeless case, if we can prolong life for months or years and at the same time keep the patient comfortable, we have done a good deal for her welfare as well as that of her family. At least we are certain that we have not added to her burden such things as atrophic skin, radiation dermatitis, severe itching, sloughing, induration, and ulcerations, some of which prove to be more painful and uncomfortable than the primary disease.

Almost all of the patients seen in the Roentgenological Therapy Section have had administered 3,000 to 4,800 mg. hours of radium in the usual manner, one to three weeks previously. A few of the very far advanced cases plus a few of the very early cases are given no radium therapy, depending on the findings of the referring gynecologist and the radiological consultant. The present routine technic for the treatment of a woman of average size who is referred with a diagnosis of squamous-cell carcinoma of the uterine cervix is as follows:

When the patient reaches the Roentgenological Therapy Section, seven portals are used with the indicated roentgens (measured in air) delivered to each field:

Portal	Dose, r	Field Size, Cm.
Anterior right pelvis	1,400	20 × 20
Anterior pelvis mid-line	1,400	10 × 15
Anterior left pelvis	1,400	20 × 20
Posterior right pelvis	1,400	20 × 20
Posterior pelvis mid-line	1,000	10 × 15
Posterior left pelvis	1,400	20 × 20
Anterior vagina	800	8 × 10
TOTAL	8,800 r (measured in air)	

The technical factors are 200 kv.p., Thoræus filter (0.25 mm. Cu, 0.45 mm.

Sn, 1.0 mm. Al), h.v.l. 1.9 mm. Cu. Only one portal is treated a day, with the daily dose of 200 r to each portal. The central ray in each position is always directed toward the cervix. The anterior vaginal dose is given with the patient in a modified lithotomy position and the central ray directed toward the focus of the disease with a 6 × 8 cm. cone in contact with the vulva.

The percentage depth dose with the fields and the technical factors noted above, determined both experimentally and from the literature, works out to be 55 per cent of the air dose, and the skin receives about 10 per cent fewer roentgens than where an h.v.l. of 1.0 mm. of Cu is used. The tumor dose is approximately 4,800 r.

To continue the ideal treatment of this case, if it is of Stage III or IV, a second series of 4,800 r in air is administered about six months later through four portals about the pelvis, with 1,200 r to each area, with the same physical factors as above. In Stage I or II, if the pelvic findings show no extension following the first series, a complete abdominal hysterectomy is recommended.

It should be pointed out here that for a short period near the end of this series we were in possession of a contact therapy machine and 5 patients were treated with it, 3 of whom have been followed for at least five years and are still alive. The contact therapy machine was substituted for the radium, and the radiation about the external pelvis was reduced about one quarter.

The ease of controlling the wave length, and thereby the penetration, as well as the direction of the central ray are decided advantages of contact therapy over radium in this disease which exists so near to such important and vulnerable structures.

SUMMARY

1. There are presented the five-year end-results of an unselected series of 98 cases of squamous-cell carcinoma of the uterine cervix.

2. A 76.5 per cent follow-up was obtained, with an over-all five-year survival rate of 23 cases, or 30.6 per cent.

3. Graphic comparison of results obtained with different filtration is presented.

4. The present method of treatment is outlined, and the reasons for heavier filtration than is used in the majority of x-ray clinics are discussed.

5. The advantages and results of contact therapy are mentioned.

Though the series of cases is small, one is impressed with the high percentage of five-year survivals in Stages I and II. In Stage III the percentage of five-year survivals is correspondingly small, and in Stage IV practically negligible.

Why should there be Stages III and IV, if we can salvage more than 70 per cent of Stage I cases over five years? Is not something radically wrong from a diagnostic standpoint? There must be two very definite reasons why patients are allowed to go undiagnosed until they have extension well beyond the cervix, uterus, and into the surrounding tissues.

1. Has the patient failed to consult her physician because of lack of education or lack of information regarding the seriousness of a cervical carcinoma or some of the important symptoms?

2. Does the fault lie with members of our profession? Certainly any physician has access to private and municipal laboratories which can give an accurate diagnosis from a section taken at biopsy.

DISCUSSION

The work we have done has been done with the close co-operation of the Department of Gynecology and the Department of Radiology in our hospital. All the patients have been seen by the gynecological service; the diagnosis has been made by the gynecologists and the pathologists.

The radium treatment has been given, as is the practice in our hospital, by the gynecologists, in co-operation with the radiologists. I know a great many of you

will not be in accord with this procedure. Personally, I feel that if I had one of my own who had to be treated for a cervical carcinoma, I would prefer to have a competent gynecologist apply the radium. I do not mean by that, however, that any gynecologist is competent to do radium therapy. I know we hear a great many gynecologists say: "Well, put in a little radium." I think it is very important that the gynecologist who is going to do radium therapy should be familiar with radium dosage. I do not think it would be amiss for the Gynecological Board to do as we do in the American Board of Radiology —subject these gynecologists to the same form of training that we get. In other words, they should be familiar with radium and radium dosage.

Most of the cases that we are reporting here received in the neighborhood of 3,500 to 5,000 mg. hours of radium, put in by the gynecological department. The cases were treated first with radium, followed by x-ray therapy with few exceptions—some were given roentgen therapy prior to the radium.

It has been our practice in these cases to give dosage of around 8,800 r (measured in air) to six fields, giving a depth dose of about 4,500 or 4,800 r.

The voltage, as a rule, has been 200,000 volts, either pulsating or, in some instances, constant potential. A few cases were treated at 400 kv., with a composite filter, h.v.l. 7 mm. copper. With 200 kv., a composite filter has been employed, with h.v.l. 1.9 mm. copper.

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Chicago 5, Ill.

Dr. Ernst: Thank you Dr. Jenkinson.

We shall now proceed to our questions and answers, first allowing the essayists to ask each other embarrassing questions. I will begin with Dr. Arneson. Do you have any questions to ask the Panel essayists?

Carcinoma of the Cervix: Discussion

Dr. Arneson: Two questions have occurred to me. The first is in reference to Dr. Siebert's paper and has to do with the histologic grading of biopsy specimens. In a single slide the pathologist may find examples of more than one particular type or grade of differentiation. The predominating form is used to classify the tumor. It should be noted, however, that the histologic appearance can be altered. One can follow the degenerative changes occurring in cervical cancer by repeated biopsy. Following irradiation there may be radical alteration without complete destruction of tumor. Recovery takes place rapidly, and evidence of renewed growth can be detected histologically. If a reasonable period intervenes between completion of x-ray treatment and the application of radium, biopsies made at that time will almost invariably reveal a more adult type of tumor than was present in the initial specimen. That change may be due to the action of radiation, or it may have been response to change in tumor environment. The question being asked Dr. Siebert is whether or not there is any basis for believing that the three types he described for histologic grading may represent differences in tumor age? In other words, can a tumor begin as one type and, due to greater age or maturity, become a different type?

The second question is in reference to curability of cervical cancer. Dr. Bowing reported a five-year survival rate of approximately 70 per cent among patients with early cancers. Only 6 per cent of the Group IV patients were alive at the end of the five-year period. The importance of the stage of clinical advance has been stressed as the main factor determining clinical results. If that were the only factor, we would expect all of the early cases to be cured, and we would expect no patients with advanced cancer to survive. Is the stage of clinical advance the only factor determining clinical results?

Dr. Siebert: As to histologic grading, I must admit that there is a great deal of difficulty. There is, however, one group which can well be separated from the others, that is the very highly malignant Grade IV tumors. About these there can be no doubt. There are also Grade I tumors concerning which there would be no marked difference of opinion. It is in distinguishing between Grades II and III that difficulty arises. Very few of these tumors would be mistaken for Grade I or Grade IV.

The importance of histologic grading of cancer is based on the fact that the more highly malignant growths metastasize earlier. Since curability in cancer of the cervix is dependent upon the extent of the tumor, or its clinical stage, and upon its histologic grade we can thus see how grading becomes of value.

Personally I am not convinced that a tumor changes its grade. I rather think that, if we see different grades in serial biopsy specimens from the same case, these various grades were present from the beginning. There is some experimental evidence that fever therapy may perhaps increase mitosis and thus make a tumor more susceptible to irradiation, but this has no practical application so far as I know.

Dr. Bowing: Dr. Arneson's question regarding tumor advance concerns a very fundamental topic. Many interesting studies have been reported. Tumor advance is important to all therapeutic radiologists because increased knowledge of this phenomenon should result in improved methods of treatment. When the broken-dose intensive plan of radium treatment is used, one can recognize some of the gross changes in the involved field. The bleeding stops, the odor and discharge decrease, and the necrotic ulcerated surface of the lesion becomes blanched and seems to heal in much the same way as does a non-malignant ulcer. In the event of the applica-

tion of the proper radium treatment factors to meet the individual requirements of the patient, it is astonishing to observe the ultimate restoration of the previously involved structure to an apparently grossly normal state. So far, I prefer to judge the whole treatment field during the course of radium treatment rather than to observe the microscopic changes. The latter method would require the removal of multiple specimens or the removal of representative tissue from the field of treatment from time to time or at selected intervals. I am rather certain that these procedures add a definite risk and, in all likelihood, delay the treatment. We have, so far, not seen our way clear to institute the use of repeated biopsies and smears for routine study. However, we have studied the microscopic changes in irradiated tissue, chiefly in tissue irradiated before operation and in irradiated tissue removed at necropsy. In this way, the probable pattern is pieced together and it is not possible to make a complete study of each case.

MacCarty and Broders observed the presence of certain factors in their study of operative tumor tissue in the investigation of post-surgical prognosis in a variety of malignant tumors. In the main, the factors are discussed as differentiation, lymphocytic infiltration, fibrosis and hyalinization. These factors form part of a natural defense system. Various degrees of differentiation are observed only when sublethal irradiation is applied. When lethal irradiation is applied, the malignant cell is shattered, the field is chiefly made up of nuclear and cytoplasmic debris, and the resulting phagocytosis clears the way for the development of fibrous tissue and for eventual scar formation. As a rule, both lethal and sublethal effects are produced in the same field, the former in the immediate vicinity of the radium tube and the latter in distant areas. For a satisfactory local result and anatomic restoration of the involved structures with minimum scar formation, lethal irradiation effects should be kept minimal.

The grade of malignant change (Broders) is not a guide in the estimation of the prognosis after radium therapy. This statement must be qualified, because Grade I lesions are always few in number and are adenocarcinomas, while the predominant lesion is an epithelioma.

I do not know whether I am answering Dr. Arneson's question, but to me this is probably a very, very important phase of our discussion this afternoon.

Chairman Ernst: Has any one anything to add that differs with any of these comments?

Dr. del Regato: In our experience, the League of Nations classification of carcinoma of the cervix offers the best basis for a prognosis, while the histologic grading is only of relative value. We find, however, that within the same stage those tumors with a greater degree of anaplasia have perhaps a more serious prognosis. I would like to know whether or not Dr. Siebert agrees with this view. Dr. Siebert also insisted upon his preference for surgical treatment in superficially spreading carcinomas *in situ*. I should like to know if this preference is based upon experience. Has radiotherapy failed in the treatment of these early lesions?

Dr. Siebert: First, as to prognosis in the various grades of cancer: I believe there is only one instance in which we can state that we are dealing solely with a local tumor that has not metastasized—namely, a squamous-cell carcinoma, Grade I (Broders), which has been excised with at least a centimeter of uninvolved tissue on all sides. That means, practically, that the cervix has been amputated, or at least half of it has been removed. Only on a study of such a specimen could a prognosis be made. No matter how small the tumor, if it is of Grade II, III, or IV, or of the transitional or fat spindle-cell type, I believe that it is impossible to make a prognosis as to lymph node involvement.

As to my statement that I believe that early low-grade carcinomas should be treated surgically, I speak from the point

of view of the pathologist who desires a collection of early carcinomas in order to study the problem of lymphatic extension in correlation with the histologic grade. We have little opportunity in radium-treated cases, even with serial sections, to investigate this problem. If we are to advance in our understanding of cancer, especially early cancer of a low grade of malignancy, we must have specimens that can be studied in serial section, to determine whether we are right in our opinion that such tumors are local and have not metastasized. The figures of Shields Warren on this point are striking. He found that of the low-grade squamous-cell types, only 4 per cent had metastases in the regional nodes, whereas of the transitional and fat spindle-cell types approximately 90 per cent had lymph node involvement, no matter how early the appearance on clinical or microscopic study.

I hope that I have answered Dr. del Regato's question.

Dr. Ernst: Dr. Brewer, have you any questions?

Dr. Brewer: I would like to put in a word about the statistics of Warren. They are statistics at death. Those patients were treated for carcinoma. Since they were treated, might it not be that the treatment prevented metastasis, rather than that metastasis just did not occur? To make a study of lymph node metastases in untreated carcinoma is a hard job, since most patients are treated. There are not enough untreated cases in the world to add up to statistical value.

Dr. Bowing: I would like to ask Dr. Jenkinson if he can state the ages of patients who had lesions that were classified as Stage I and Stage II? The results which he has reported are very good indeed.

Dr. Jenkinson: No, I cannot do that.

Dr. Bowing: I appreciate the possibility of error in comparing similar groups of cases, especially when the number of cases in each group is small. In 13 of 1,491 cases of malignant lesions of the cervix in which the patients were treated at the Mayo Clinic, the lesion was classified as Stage I. The average age of the 13 patients was 59.3 years, and 70 per cent of the patients lived five or more years after the completion of treatment. In 85 of the 1,491 cases, the lesion was classified as Stage II. The average age of the 85 patients was 57.7 years, and 60 per cent of the patients lived five or more years.

There is a possibility that age alone was not the deciding factor against surgical intervention in these cases; for example, obesity and degenerative diseases may have been an added factor that would add to the risk of operation. There was no hospital mortality in these two groups of cases.

Dr. Ernst: I think we had better begin answering questions from the audience. The first question is directed to Dr. Brewer: Are there any 5-year survivals after surgery where lymph nodes were involved?

Dr. Brewer: The answer to that is to be found in 28 patients operated upon in Stages I and II. Ten had lymph node involvement, and at the end of five years, 3 of these survived, a survival rate of 30 per cent. Among the other 18 patients, without lymph node involvement, there were 16 five-year survivals, or 88 per cent.

Chairman Ernst: Here is another question for Dr. Brewer: Can surgery in Grades I and II cancer of the cervix produce as good or better five-year results than radiation therapy as outlined by Dr. Bowing? If not so, then why subject the patient to surgery?

Dr. Brewer: That is a good question, which, however, I cannot answer because we do not yet have an adequate group of statistics on five-year cures following surgical procedures under new conditions. They claim as good results with x-ray; they claim as good results with radium. So far, the results are only equal with surgery. In the future, however, it seems to me—and I wish to make my position clear—that in early carcinoma of the cervix—

if it is truly *early*—the treatment, primarily and fundamentally, is surgery, but that x-ray or radium should be used as adjuncts.

Dr. Ernst: There is a question directed to Dr. Waterman: Do you treat infiltration of the rectovaginal septum with needles?

Dr. Waterman: Yes.

Dr. Ernst: Have you had perforations?

Dr. Waterman: I do not recall any. We use needles often in treating cancer of the vaginal walls, metastatic or primary.

Dr. Ernst: Have you had any five-year cures with needles, if lymph nodes are thought to be involved?

Dr. Waterman: This last question is a very difficult one to answer. I do not know how anybody can tell if lymph nodes are involved in the early group unless he does a Wertheim operation. We have a 30 per cent survival rate in Stage III cases. Almost certainly some of these patients living for five years have lymph node involvement, but we cannot tell accurately which ones.

Dr. Ernst: What detailed information do you obtain about a Stage III and IV before starting treatment? What complications do you get? How do you handle them?

Dr. Arneson: An important detail of information to be sought would be the character of the growth. If the cervix was surrounded with a dense collar of infiltration obliterating all fornices, and perhaps associated with extension down the anterior vaginal wall beneath an intact mucous membrane, there would be reason to believe that the tumor had been of an infiltrating quality from its beginning. If there were extensive ulcerations, possibly associated with a large crater, the tumor could have begun as an everting type. In all forms one would have to evaluate the degree of infection and the amount of necrosis and slough. It would also be necessary to determine whether or not an adjacent viscus were invaded.

Complications in the advanced stages include persistence of tumor with extensive fibrosis and pain; post-irradiation breakdown of the tumor bed due to infection, followed by unrestrained growth of tumor; and fistula formation due to regression of cancer that had invaded the wall of a viscus.

In planning treatment one would have to choose between palliation procedures and attempts to destroy completely all of the tumor. In either instance it is oftentimes helpful to protract treatment over longer periods than might be employed for more favorable cases. Among infiltrating types, that appears to be especially important. Protraction of radium treatment is gained by using weak sources, but it is also practical to divide the treatment into multiple applications made at different intervals. For any protraction of irradiation there must be an adjusted increase in the total amount of radiation.

Dr. Ernst: Here is another question directed to Dr. Brewer: What form of treatment would you advise in a patient with cancer of the cervix who is three or four months pregnant?

Dr. Brewer: That is a good question. I have already made a note of it to ask the others. My answer is simply this: When there are two such conditions present, one treats the essential disease, and the essential disease is carcinoma of the cervix. Our procedure in such a patient is abdominal hysterectomy and irradiation of the cervix—irradiation with radium, followed by x-ray.

Dr. Ernst: Someone asks Dr. del Regato a question regarding the treatment of carcinoma of the cervical stump.

Dr. del Regato: A very appropriate question. It is well known that carcinomas developing on the remaining cervix, after subtotal hysterectomy for a benign condition, have had a relatively poor prognosis. This is due to inability to irradiate them with radium as thoroughly as would

be desirable, because of the shortness of the uterine canal. In that respect transvaginal roentgen therapy constitutes a definite advantage and I believe that the prognosis of these cases will be improved with its use.

Dr. Ernst: Someone else—a gynecologist—asks about the position in which to examine the cervix. Dr. Brewer, what position do you feel is best for examination of the cervix?

Dr. Brewer: I think that depends on what you can see, and whether you can see. We routinely examine all patients with the legs elevated and the knees bent, with insertion of a speculum. If we cannot see adequately, we do as Dr. Bowing mentioned—turn the patient up in the knee-chest position and fill the vagina with air, which is quite easy, and may permit you to see more.

Dr. Ernst: Here is another question directed to Dr. Brewer. Is there any advantage in giving the patient external radiation prior to your operation?

Dr. Brewer: We personally do not use it, although I can see no objection to deep x-ray therapy prior to surgery. Following irradiation we have done hysterectomies, and we find no increased technical difficulties due to such irradiation. We do believe that surgery should be preceded by irradiation of some sort, but we prefer radium.

Dr. Ernst: This question is directed to all of the essayists: What procedure do you recommend when there is evidence of ureteral obstruction? Would you like to answer that, Dr. Waterman?

Dr. Waterman: We have adopted the practice of studying the condition of the kidney and the ureters before each case is treated. If we discover an obstruction, a hydronephrosis on one side or the other, we find out what the functional tests show. If the patient is in good shape, we are apt to start with deep x-ray therapy before we give radium. Then, at the proper time, we go ahead and treat the lesion just as we would any lesion.

If one kidney is functioning well, we are inclined to treat the cancer and ignore the obstruction unless it is giving rise to temperature or other complications, in which case proper treatment for the condition is instituted. After all, it is a cancer that we are treating, and if the patient's condition is good, she has to take her chances on an injury. I think that, with our particular method, we miss the ureters generally.

Dr. Ernst: Do any of the essayists have anything to add?

Dr. Bowing: May I comment on the plan of routine urinary investigation? At the Mayo Clinic, we do not employ a routine urinary investigation in all cases. In cases in which the symptoms and physical findings may indicate certain urinary examinations to rule out urinary disease or complications, the selected procedures are recommended by the clinician, the therapeutic radiologist, or in consultation with the urologist. Furthermore, in all cases in which operation or irradiation therapy has been employed and further treatment is being considered, a routine urinary investigation is indicated. As a rule, the most revealing single urinary examination is excretory urography.

Serious urinary complications occur in cases in which the lesions are classified as Stage IV. In such cases, palliation is all that can be expected from a limited or cautious irradiation technic. In some cases, however, irradiation therapy will produce an astonishing improvement in the urinary complications. Our plan is to apply radium therapy to the vagina and, if possible, to the uterine cavity in limited dosage and to supplement the treatment with roentgen therapy. We have observed a small number of cases in which a good initial or early result was obtained.

Dr. del Regato: I would like to say in that respect that we do not think that the presence of hydronephrosis is in itself a

contraindication to treatment but that it reaffirms the necessity of starting with the external irradiation of the patient. I believe Dr. S. T. Cantril, of Seattle, has reported two cases of marked compression of the ureter that disappeared entirely under treatment.

Dr. Ernst: Here is another question: How many surgeons in the country are qualified to do operations as described by Dr. Meigs?

Dr. Brewer: I would not know. It amounts to this. Meigs was not qualified when he started. Bonney was not qualified when he started. That is why I stressed, in my short presentation, that surgery should be done in good teaching research groups by a competent surgeon who will make the proper study. Cases should be sent to him so that he can rapidly accumulate numbers and also acquire technic.

Dr. Ernst: I probably differ from some of the essayists who seem to feel that we have more or less reached the limit of mechanical methods for the application of radium or x-rays in carcinoma of the cervix.

Improved Methods of Intravaginal Roentgen and Radium Therapy in Carcinoma of the Cervix

EDWIN C. ERNST, M.D.
St. Louis, Mo.

WE HAVE recently designed and developed several useful mechanical procedures for the irradiation of cervical cancer. At this opportune time, we wish to demonstrate the probable future significance and clinical application of these methods.

Early in 1945, after reviewing our private and clinical results at the De Paul and Barnard Free Skin and Cancer Hospitals, we realized the need for more effective and safer methods of employing larger radium dosages in the treatment of cancer of the uterine cervix. We had in mind a new type of single-unit radium applicator —one that would be more flexible and equally effective for meeting the requirements of the many different forms of distant parametrial involvement and vaginal vault extension.

Since that time we have exhibited many different models and improvements upon the originally designed combination cervical radium applicator and expanding colpostats, but the fundamental physical principle of uniform "fool-proof" spacing of the multiple radium sources or capsules has been preserved in the newer models of these applicators as shown in Figure 1.

We have clinically compared the initial erythematous and subsequent vaginal wall reactions following the use of this single unit applicator with those associated with our former "hit-and-miss" methods of indiscriminate packing of multiple radium capsules and spring colpostats, and in not a single case have we observed localized "hot spots" or tissue necrosis.

The improved uniform distribution of the radiation obtained by this method is undoubtedly due to the fact that from seven to nine radium containers are spaced 1.0 cm. apart in both the vertical and horizontal planes. This composite radium applicator is introduced as a single unit into the cervical canal and along the cervical vaginal walls. The colpostats or radium capsules are then expanded into the fornices and parametrium, and this

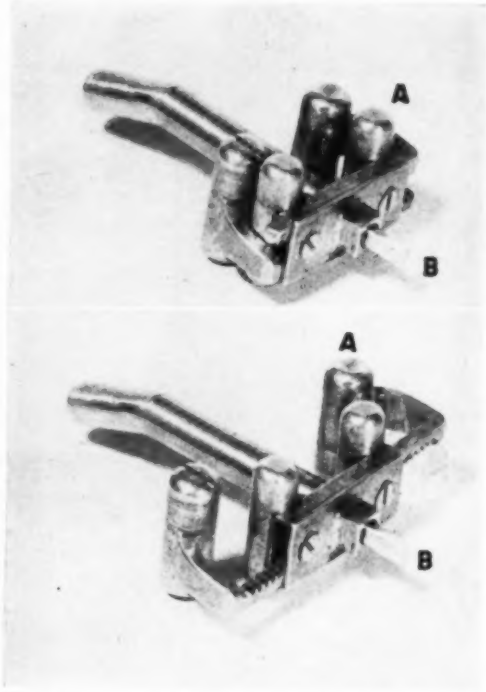

Fig. 1. Expanding colpostat of the rack-and-pinion type in the open and closed positions. In the closed position (above) the colpostats measure 3.5 cm. in width; in the open position (below) 5.7 cm. The top and bottom of the vertical colpostats (A) contain the equivalent of 3 mm. lead for the protection of the bladder and rectal structures. The square shaft (B) facilitates introduction and expansion of the colpostats.

In the open position the seven or more sources of radium are automatically spaced 1 cm. apart.

[1] Presented at the Second Mexican Cancer Congress, Guadalajara, February 1946; at the Second Inter-American Congress of Radiology, Havana, Cuba, November 1946; at the Thirty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., December 1946.

fixes the positions of the seven or nine radium capsules. There is little chance for subsequent displacement or shifting of these multiple units within the vaginal vault, thus assuring greater irradiation

"rack and pinion" gear type, while Figure 2 shows another practical applicator in which there is incorporated a "lever-jack," scissor-like mechanical action for spreading the colpostats.

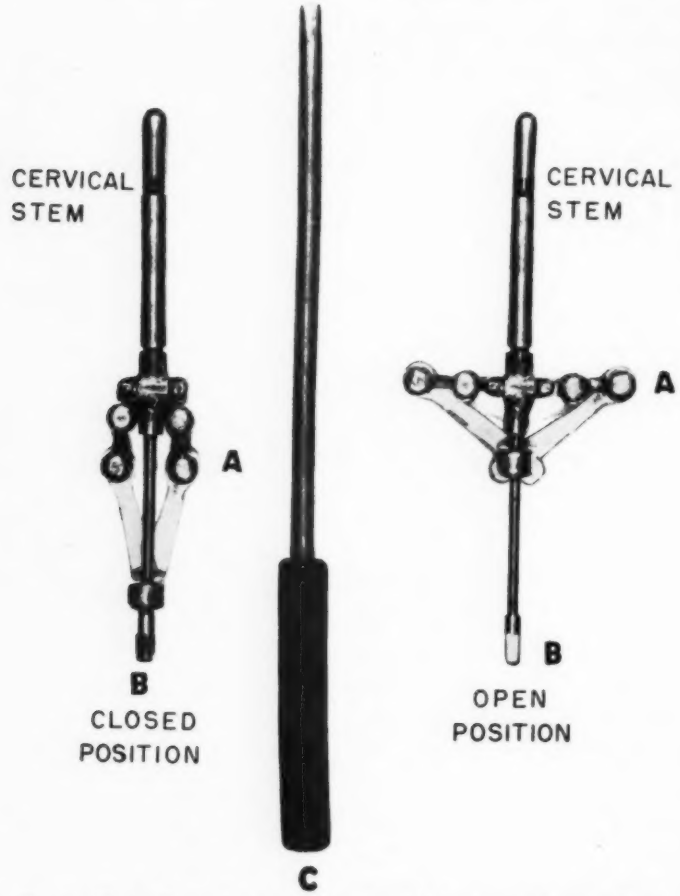

Fig. 2. Expanding colpostats of the lever-jack, scissor-like type in the open and closed positions. In the closed position the transverse diameter of the colpostats measures 2 cm. This composite colpostat may be introduced through the average speculum.

A. Additional lateral colpostats may be added by means of a special attachment for increasing the expansion of the colpostats when the vaginal vault is unusually broad.

B. A square shaft facilitates introduction and expansion of the colpostats. Thus all sources or capsules of radium remain 1 cm. apart.

effectiveness, with added safety to the normal structures.

Two types of expanding colpostat, illustrated here, are both mechanically controlled by long applicator rods. The radium holder shown in Figure 1 is of the

The time required for the introduction and fixation of the applicator in position is but a few seconds, rather than minutes. No special skill is necessary for the application of this holder other than the preparatory dilatation of the cervical canal.

The lateral expansion feature of the colpostats within the vaginal vault and fornices facilitates the direct irradiation of the parametrial regions. Not infrequently additional colpostats can be attached and expanded even behind the primary cervical lesion. Furthermore, the displaced cervical canal and body of the uterus in the average case can be retracted to a more central and vulnerable position, thereby enabling the expanding colpostat to assume a more effective position in closer proximity to the parametrium.

Each capsule or radiation center will accommodate three (5 or 10 mg.) needles, radium cells, or a larger single radium capsule. The filtration in the cervical stem and colpostats is the equivalent of 1.0 mm. platinum. The above filtration factors and diameter of the compartments within the capsules may be increased or decreased, or metallic brass may be substituted for platinum, to meet the available supply of radium or the desired specifications of the radiotherapist. The bladder and rectal fields are protected from the direct radiations by 3.0 mm. of lead and 2.0 mm. of brass placed within the upper and lower ends of the vaginal capsules.

For transvaginal x-ray therapy in cancer of the cervix our procedure involves the use of translucent, plastic, intravaginal x-ray cones (Fig. 3) rather than opaque or metallic specula. These plastic cones can be molded to conform with the different shapes, sizes, and diameters of the vaginal vault. The lucite or plexiglass commercial tubing can thus be molded or bent into any desired shape at approximately 300 degrees while the thinner acetate butyrate tubing, when placed over the average gas stove flame or Bunsen burner, requires only 225 degrees of diffuse heat.

These plastic materials are translucent to both artificial light and roentgen rays. The lucite plastic tubing has the additional physical property of piping the artificial light along its walls, thus improving the vision of the cervical field under observation.

Even as a vaginal diagnostic procedure, we prefer these plastic cones to the ordinary metallic Graves' speculum. The primary lesion and the surrounding structures within the vaginal vault can be directly outlined, and this is especially desirable for identifying certain landmarks when radiating multiple fields. Overlapping of multiple fields under these conditions can be minimized to a greater or lesser extent. Following the introduction of one of these "tailor-made" plastic cones over the field to be irradiated, this tube can be fixed to the patient by a binder or adhesive tape. Within the internal opening of the plastic cone there may be inserted short auxiliary metallic cones (Fig. 3) of different lengths, depending upon the depth of the vaginal vault and the position of the urethra. The x-ray beam is then directed through this opening or lead-protected cone.

Fig. 3. Transvaginal plastic translucent cones and lead-lined inserts for direct roentgen therapy. Note the different sizes, shapes, and lengths, all of them tailor-made to conform to the unusual vaginal vault outlines.

The limits of the distribution of the x-ray beam within the vaginal vault depend upon the length and diameter of the inserted lead cone, and any variations from the normal can be indirectly calculated in advance for each type of cone employed. The shorter the lead insert the broader the x-ray field.

This method, in my opinion, presents added practical advantages over our past procedures of indirect (periscopic) or blind application of transvaginal x-ray therapy with metallic cone methods. A few clinical comments may be added in conclusion:

(1) In approximately 29[2] moderately advanced cases of cancer of the cervix a radiographic check of the position of the radium colpostat failed to disclose a single instance of displacement or shifting of the position of the radium capsules. The reverse has been our experience following insertion of many individual radium capsules in the vaginal vault.

(2) On the basis of our initial observations and clinical experience in the treatment of all stages of cancer of the cervix during the past two years, we believe that the advantages of these radium applicators and plastic cones, as enumerated, have been fully established.

(3) If it is desirable to fractionate the radium treatment, the ease of introduction of the radium colpostat is a further advantage for daily or weekly applications.

(4) The ease and rapidity with which this radium applicator can be placed in position in the cervical canal and vaginal vault with the aid of a long-handled applicator considerably reduce the amount of radiation exposure to the operator and his coworkers.

(5) It should be emphasized that this description of the instruments and methods employed, and the mechanical and physical factors involved, is presented only as a preliminary report. Final evaluation of the clinical effectiveness of these methods is deferred for later communications.

[2] Twenty additional cervical cancer cases have been examined since the above presentation.

Barnard Free Skin and Cancer Hospital
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Dr. Ernst: We do not have time for any further questions, but I believe that this symposium has furnished us much material for our future guidance.

SUMARIO

Diagnóstico y Tratamiento del Carcinoma del Cuello Uterino: Repaso por un Jurado

Certamen relativo a las varias fases del cáncer del cuello uterino, celebrado durante la reunión anual (1946) de la Sociedad Radiológica de Norte América.

Diagnóstico Clínico
(A. N. Arneson)

El comportamiento clínico del carcinoma cervical varía conforme a las propiedades biológicas de la neoplasia, y en el pronóstico hay que tomarlas en cuenta, junto con la etapa de la evolución clínica y el aspecto histológico. Los tipos de proliferación externa o proyección son radiosensibles y ofrecen en general un pronóstico favorable. En estos casos el lecho del tumor puede tolerar bastante bien una irradiación de intensidad relativamente alta, pero resulta más práctico aplicar un tratamiento de menor intensidad. En las formas infiltrantes el pronóstico es malo debido a la resistencia a la irradiación y a que, al hacer el diagnóstico, frecuentemente ya están muy avanzadas. En este grupo, el tratamiento de poca intensidad resulta indispensable. Si la roentgenoterapia es prolongada o si se divide la dosis de radio en varias aplicaciones, puede alargarse la duración total del tratamiento, administrándose así dosis totales mayores. Las formas en cráter son relativamente radiosensibles, pero plantean un problema especial debido a la presencia de infección. La irradiación poco intensa esparcida durante un período prolongado resulta más eficaz en ellas que las dosis grandes administradas durante un período más breve.

Anatomía Patológica
(Walter J. Siebert)

Patológicamente, puede clasificarse a los tumores del cuello uterino de acuerdo con la porción del recubrimiento escamoso de la sección vaginal del útero, en la cual tienen su origen. Por ejemplo, proceden de la capa superior los carcinomas espinocelulares con su bajo coeficiente de metástasis ganglionares; de las células de transición, más profundas, los carcinomas de células de transición; y de la capa basal o germinal, los cánceres fusocelulares, con sus propiedades de invasión rápida. De estos últimos, casi 90 por ciento atacarán los ganglios linfáticos. Cada uno de dichos grupos puede subdividirse de nuevo conforme a su mayor o menor diferenciación, en Grados I, II, III y IV.

Recálcase la importancia de las biopsias en serie, sobre todo en los casos tempranos y sospechosos.

Cirugía
(John I. Brewer)

El tratamiento quirúrgico del carcinoma cervical está limitado a los Períodos I y II (clasificación de la Sociedad de las Naciones) y debe emprenderse en un limitado número de casos: primero, por no obtener la radioterapia una proporción suficiente de curaciones de cinco y diez años; segundo, debido a la baja mortalidad operatoria; y por fin, por permitir eliminar posibles asientos de recurrencia. La cirugía facilita, además, tejido para examen, el cual, debidamente estudiado, debe acrecentar nuestros conocimientos del cáncer. Sólo se apoya una clase de intervención, a saber, la Wertheim, ya clásica o modificada, extirpando todo el útero, los tejidos de los ligamentos anchos y los anexos.

En la actualidad, no debe haber un cambio de frente general hacia la cirugía en el carcinoma cervical, pero sí deben emprender una justipreciación a largo plazo de este método terapéutico los cirujanos técnicamente idóneos que estudiarán su material patológicamente y observarán sus casos adecuadamente.

Curieterapia Intracavitaria
(Harry H. Bowing)

La curieterapia intracavitaria, con una técnica de dosis intensas fraccionadas,

permite una amplia individualización para el mayor número de las enfermas que tienen carcinoma del cuello uterino. Esos tratamientos pueden tener por fin la curación o la paliación. La respuesta subjetiva y objetiva es bastante rápida. Con el transcurso del tiempo se han acumulado estadísticas favorables que alientan a perfeccionar esta técnica conservadora de curieterapia para el carcinoma del cuello uterino.

Se usa el tubo corriente de platino (paredes de 1 mm. de grueso) que contiene 50 mg. de sulfato de radio. Cada aplicador puede contener uno o más tubos. En la mayoría de las lesiones del Período III el tiempo de aplicación es de tres a veinticuatro horas, con una dosis de 300 a 2,400 mg.-horas. El intervalo entre aplicaciones dura de uno a siete días. El tiempo total puede llegar a diez a veintiún días. La región tratada se divide en zonas, siendo la dosis para cada zona la siguiente: zona vaginal, 2,100 mg.-horas; zona cervical proximal, 1,400 mg.-horas; zona cervical distal, 1,400 mg.-horas; zona intrauterina, 2,000 a 2,400 mg.-horas. La roentgenoterapia, iniciada algunos días antes de completar la curieterapia, se administra a través de 2 campos anteriores y 2 posteriores: 500 a 700 r a cada campo.

Curieterapia Intersticial
(George W. Waterman)

El empleo de agujas largas de radioelemento con filtros de 2 a 3 mm. de platino, ofrece la gran ventaja de que permite introducir el radio en los tejidos de la zona invadida. Las agujas pueden complementarse con una cápsula de platino de 20 mg. de cabida, colocada en el conducto cervicouterino. Todo el radio se deja en su sitio por espacio de 168 horas, por creerse que este tratamiento prolongado representa un factor importante en la desaparición de las células cancerosas y en la conservación y tal vez fortalecimiento de los tejidos circundantes. La técnica es sumamente flexible y fácil de aplicar; todo el tratamiento se administra en una dosis, evitándose en gran parte las complicaciones debidas a la irradiación.

En los últimos 198 casos del A., la sobrevivencia absoluta de cinco años representó 38.9 por ciento. En 171 casos que recibieron la curieterapia, las curaciones de cinco años llegaron a 44.4 por ciento.

Roentgenoterapia Transvaginal
(Juan A. del Regato)

Para la roentgenoterapia transvaginal del carcinoma cervical, que complementa la irradiación externa, se utiliza un espéculo compuesto de una cabeza de metal destinada a proteger la vulva y de un vástago transparente a la radiación. Esto permite obtener una amplia irradiación del cuello uterino, fórnices y porciones adyacentes de los parametrios, a la vez que se resguarda, de ser necesario, la vejiga y el recto. Prefiérese una radiación de penetración moderada (140 a 150 kv.), con filtros pesados (0.5 mm. Cu). La distancia foco-cuello es de 25 cm. La dosis representa 3,000 a 4,000 r (en el aire) al nivel del cuello, administrada en diez a doce días.

Entre 52 enfermas consecutivas, todas las cuales, con excepción de 2, recibieron la roentgenoterapia externa, seguida de la aplicación transvaginal de rayos X, 22 estaban vivas sin signos de cáncer al cabo de tres años, o sea una sobrevivencia de 42 por ciento.

Resultados Terminales a los Cinco Años
(Edward L. Jenkinson)

Preséntase el resultado terminal a los cinco años en una serie sin seleccionar de 98 casos de carcinoma céluloescamoso del cuello uterino. Pudo seguirse a 76.5 por ciento, representando la sobrevivencia global de cinco años, 30.6 por ciento (23 casos). La mayor parte de las enfermas había recibido la curieterapia—3,000 a 4,600 mg.-horas—antes de la roentgenoterapia. La última se suele administrar por siete vías distintas, tratando una cada día con 200 r, y administrando una dosis total de 4,800 r. Un filtro de Thoraeus (0.25 mm. Cu, 0.45

mm. Sn, 1.0 mm. Al) es el que ha dado mejor resultado. En los casos de los Períodos III y IV, puede administrarse otra serie de tratamiento al cabo de seis meses. En los Períodos I y II, sin propagación después de la primera serie, recomiéndase una histerectomía abdominal total.

Nuevos Dispositivos para la Aplicación de Rayos X y Radio
(Edwin C. Ernst)

Descríbense, con grabados, tres nuevos dispositivos para la irradiación del carcinoma cervical: conos plásticos, forrados de plomo, y diseñados de modo que se conformen al contorno de la bóveda vaginal, para la roentgenoterapia directa, y dos tipos de colpóstatos expandibles con múltiples focos de radio a distancias de 1 cm.

Giant-Cell Tumors of Bone[1]

LT. COL. FRANKLIN B. BOGART, M.C., A.U.S. (Inactive), and MAJ. ALLISON E. IMLER, M.C., A.U.S. (Inactive)

DURING THE PERIOD from Jan. 1, 1942, to Oct. 1, 1945, 656 patients were admitted to an army hospital designated as a radiation therapy center. Of this number, 25 had primary bone tumors, including 10 giant-cell tumors in the diagnosis or treatment of which we participated. A number of other giant-cell tumors were seen in consultation with other installations or as follow-up cases. Our opinions are influenced, also, by our experience prior to active military service and to some extent by the views of others as expressed in various publications. No statistical study will be attempted; cases presented are illustrative of certain features of the disease.

In this hospital all cases were seen by a tumor board composed of a radiologist, pathologist, surgeon, and internist, and by representatives of appropriate specialties in selected cases. The decision as to the method of treatment was made by this board.

Those desiring a review of the historical aspects of giant-cell tumors are referred to the bibliography. Important data are contained in the articles by Kolodny (20), Kirklin and Moore (19), Geschickter and Copeland (13, 14), Leucutia, Witwer, and Belanger (21), Pfahler and Parry (26), and Jaffe, Lichtenstein, and Portis (16).

METHODS OF TREATMENT

While most giant-cell tumors are benign, there is evidence to indicate that some are malignant from the outset or eventually become malignant. When tumors thought to be benign are later proved to be malignant, it would seem more reasonable to assume a lack of diagnostic acumen in the first place than to attribute malignant change to curettage, roentgen therapy, or infection. We believe that each case should be studied clinically, roentgenographically and, where possible, by biopsy. Malignant cases should be treated by radical surgical methods where the lesion is accessible. Cases that appear to be benign should be treated conservatively. Both roentgen therapy and conservative surgical methods give good results. Surgical methods, however, cannot be successfully used when the lesion is inaccessible, as in the spine or pelvis. Our personal preference is for roentgen therapy in all benign giant-cell tumors.

It has been pointed out in the past that following a series of x-ray treatments some giant-cell tumors temporarily increase in size and show an aggravation of symptoms. A period of many months is required before the final results of radiation therapy are obtained. Our experience has been that this temporary increase in the size of the tumor, with aggravation of symptoms, does occur in some cases. Instances are encountered in the literature where surgery has been resorted to within two months following roentgen therapy and the statement is made that irradiation was unsuccessful (15). Such a conclusion is not justified.

We do not believe that the roentgen doses at present advocated for children—a series of approximately 100 to 200 r delivered into the tumor and repeated at intervals of one to three months for two to four series—will cause epiphyseal damage. In some of our cases we have used much larger doses where growing epiphyses were not involved, giving as high a tumor dose as 1,500 r, with a second series of half that amount two months later. Our experience and that of many others would indicate that no better results are obtained with large doses, and we advocate using the small doses mentioned above. We agree with the previously expressed opinion (26)

[1] From The Radiological Branch, Letterman General Hospital. Presented at the Thirty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–6, 1946.

that where no damage results to skin and soft tissues, no damage will result to the epiphyses.

We do not see the necessity of combining x-ray therapy with surgery in the average case. If the surgical removal of the diseased tissue is complete, postoperative irradiation is not necessary. Many have observed that cases previously treated by curettement do not subsequently respond satisfactorily to roentgen therapy; we concur in this opinion. Hence, lesions which have recurred following surgical removal are believed to be best handled by surgery if the proper surgical approach can be attained.

BIOPSY

While we feel that in many cases the roentgenographic findings will make possible a correct diagnosis, we believe that routine biopsies are desirable. With present-day surgical methods, and with bone lesions coming to biopsy relatively early in the course of the disease, there is no hazard in doing a biopsy. Correlation of biopsy data with the clinical history and roentgenographic findings should ultimately establish criteria on which to base a differentiation between benign and malignant giant-cell tumors of bone.

MICROSCOPIC PATHOLOGY

It is not within the scope of this presentation to enter into a detailed discussion of the microscopic pathology of giant-cell tumors. A careful review of the literature makes it apparent that there is no agreement among pathologists as to the etiology of these tumors or as to the relative importance of the giant cell and the stroma cell in their classification. Meyerding and Broders (24), reporting a group of seven giant-cell tumors of bone which were clinically and microscopically malignant, based their microscopic diagnosis on the appearance of the stroma cells. W. B. Coley (7) reviewed the literature and reported a group of cases diagnosed as benign giant-cell tumor from biopsy tissue and x-ray films, which later underwent malignant change. He estimated that this malignant change might be expected in as high as 15 per cent of cases.

Pathologic discussions of tissue characteristics include, in addition to the appearance of the so-called typical giant-cell tumor, a description of several variants. The variants commonly described are the spindle-cell, chondromatous, xanthomatous, myxomatous, acute giant-cell cystic (12), and an osteolytic type (12, 19). Jaffe, Lichtenstein, and Portis (16) do not believe that these variants represent giant-cell tumors and hold that when the term giant-cell tumor is restricted to the so-called typical form, malignant changes occur in a high percentage of cases. These authors also believe that, in this restricted sense, practically all giant-cell tumors will be found in patients over twenty years of age. Their classification and grading of giant-cell tumors are based upon the appearance of the stroma cells. So-called "brown tumors" are thought by them to represent only pigmented fibrous tissue scars containing osteoclasts.

The reader is referred to the bibliography for discussion of the theories of the etiology of giant-cell tumors, chief of which are the neoplastic theory, the non-neoplastic theory, and the traumatic theory.

GIANT CELL TUMORS OF THE SPINE

Four giant-cell tumors of the spine were seen. Case 1 was reported in detail in a previous communication (2). Cases 2 and 3 received their radiation therapy at this hospital. The fourth case, which is not reported in this paper, was diagnosed here and referred elsewhere for radiation therapy.

Giant-cell tumors of the spine are frequently spindle-cell variants and respond satisfactorily to x-ray therapy. It is our opinion that they are best treated by radiation alone. Recalcification of the tumor mass supports the spine, and this does not occur when the tumor tissue has been removed surgically.

CASE 1: This case was reported in detail in a previous publication (2). The patient was a male aged 20 years, who gave a history of trauma to the

neck on two occasions, eight and twelve months previous to his entering the hospital in August 1943. He had had pain in the neck for many months and just before admission numbness in the left arm had developed. X-ray examination showed destruction of the spinous process, the laminae, the inferior facet, and a portion of the superior facet of the fourth cervical vertebra. Biopsy, Aug. 27, 1943, showed benign giant-cell tumor of the spindle-cell variety. One pathologist called the lesion "dysplasia of bone."

The patient was transferred to our hospital for x-ray therapy from an overseas installation and treatment was started Nov. 3, 1943. Between that date and Nov. 13, 1,000 r were delivered to each of two lateral ports, centered over the involved area. Alternate ports were treated daily. The daily dose was 200 r and the factors used were 200 kv., added filter 0.5 mm. Cu plus 1.0 mm. Al, 18 ma., 28.5 r/min. measured in air, skin-target distance, 50 cm., h.v.l. 0.9 mm. Cu. The estimated dose to the center of the tumor was 1,380 r.

Between Jan. 1 and Jan. 5, 1944, 500 r additional were given to each port, both being treated daily. The factors used were the same and the estimated tumor dose was 690 r, bringing the total tumor dose to 2,070 r. This dose is larger than is usually given and, while good results were obtained, it is thought to be needlessly high.

From the time the diagnosis was first made the head was supported by a brace or a body cast. Films were made at frequent intervals. Calcification of the tumor was observed early. By March the calcification appeared complete and the brace was discarded. The pain and numbness in the left arm had disappeared by the middle of December 1943, and the patient remained symptom-free after the removal of the brace. The only residual disability was slight limitation of motion of the cervical spine.

Fig. 1. Case 2: Anteroposterior view, showing bone production in soft tissues adjacent to pedicles of the second and third lumbar vertebrae.

This case demonstrates that benign giant-cell tumors will respond to roentgen therapy. It also demonstrates that the calcification which takes place in a giant-cell tumor of a vertebra lends support to the spine. We believe better results are obtained when curettage is not done.

CASE 2: A white male, age 21 years, was admitted by transfer to this hospital May 18, 1945. He had received an acute injury of the lumbar spine in May 1943, having twisted his back when he stepped into a hole. X-ray films made soon after the injury were said to be negative. Since that time the patient had suffered from recurring episodes of pain which were most severe while he was lying in bed. In November 1943, he first noticed a palpable mass in the mid-lumbar region and about the same time he began to experience pain in the right hip, radiating down the right thigh. Recurrence of the pain at various intervals finally led the patient to report on sick call in December 1944, when he received some physiotherapy. About March 1945 he again reported on sick call, at which time x-ray films revealed a lesion of the laminae of the second and third lumbar vertebrae on the right. Both transverse processes were involved, but no changes were seen in the vertebral bodies. There were both bone destruction and bone proliferation.

On physical examination the patient was found to stand with a definite lumbar scoliosis with the concavity to the right. There was marked bilateral muscle spasm in the lumbar region. Moderate kyphos deformity and some tenderness were noted at the level of the third lumbar vertebra. There was practically no motion in the lumbar spine, limitation apparently being due to muscle spasm. Reflexes and sensation were intact.

The following examinations were normal: x-ray film of the chest; urinalysis, including Bence-Jones protein determination; sedimentation rate; red, white, and differential blood counts and hemoglobin determination; clotting time; tuberculin test; and coccidioidin skin test.

Fig. 2. Case 2: Lateral view, showing destruction of pedicles of second and third lumbar vertebrae. The vertebral bodies are not involved.

Our x-ray examination confirmed the observations made two months previously. The disease process involved the pedicles of the second and third lumbar vertebrae on the right side and both transverse processes. While there had been considerable bone destruction, there had also been bone production. Several large spurs of bone were visualized, extending into the surrounding soft tissue. No involvement of the vertebral bodies was demonstrated. X-ray examination of the principal bones of the body did not reveal any other lesions.

A biopsy was done May 18, 1945. The material

obtained consisted of numerous small pieces of reddish-tan tissue, some containing spicules of bone. The largest piece of tissue measured 0.7 × 0.8 × 1.6 cm. Microscopic sections revealed bone, connective tissue, and a small amount of muscle. Numerous bony trabeculae were seen with intervening connective tissue containing blood vessels. Areas of recent and old hemorrhage were also present. There were macrophages containing hemosiderin pigment and numerous large multinucleated giant cells averaging 8 to 10 nuclei per cell. These nuclei were round or ovoid and moderately basophilic. The cytoplasm was abundant and rather deeply eosinophilic. In some areas the bony trabeculae were surrounded by large columnar osteoblasts which rimmed the entire periphery and in some areas appeared pseudo-stratified. In other areas the osteoblastic activity was much less marked, and the trabeculae were surrounded by flattened cells. There was considerable hemorrhage in the adjacent connective tissue and muscle. Scattered lymphocytes and mononuclear cells were also noted in the adjacent tissue. The histologic picture was that of giant-cell bone tumor. The giant cells, however, were smaller and had fewer nuclei than the typical giant-cell tumor of bone. There was also more new bone formation than is usually seen, and the stroma was less prominent.

It was the opinion of our pathologist, Lt. Harlan I. Firminger, that the tumor was a benign giant-cell tumor. The Army Medical Museum thought that the lesion represented an ossified hematoma.

Between June 21 and July 2, 1945, 800 r of x-ray were given through a 15 × 15-cm. port centered over the lesion, 200 r being given every third day. The factors used were 200 kv., filter 0.5 mm. Cu plus 1.0 mm. Al, 18 ma., 28.5 r/min. measured in air, skin-target distance 50 cm., h.v.l. 0.9 mm. Cu. The estimated dose to the center of the tumor was 776 r. The patient experienced prompt relief of pain within the first forty-eight hours and within ten days relief was almost complete. Between Sept. 5 and Sept. 17, 1945, an additional 800 r of x-ray were given, using the same factors.

The roentgenographic evidence of bone destruction and the prompt relief of pain support the diagnosis of giant-cell tumor made by our pathologist. This case illustrates the fact that good results can be obtained in giant-cell tumors of the spine when they are treated with small doses of radiation.

CASE 3: A white male, age 29, gave a history of falling during the latter part of 1942 and striking his sacrum against a crate. As a result of the accident there were some soreness and pain in the region of the sacrum for about one month. During 1943 there were complaints of vague discomfort and a sense of fullness in the region of the sacrum. These symptoms persisted, gradually increasing, and the patient was finally hospitalized at an overseas hospital Aug. 21, 1944. Examination showed a rounded mass pressing on the rectum, apparently arising from the sacrum. X-ray study revealed destruction of the 4th and 5th sacral segments and bone proliferation which had produced a mass corresponding with the palpable tumor. A careful physical examination showed no evidence of metastases and a chest film was negative. On Aug. 24, 1944, at an overseas general hospital the tumor was surgically exposed and the coccyx and the 4th and 5th sacral segments were resected. The operator, however, felt that all the tumor tissue had not been removed. The tentative diagnosis was malignant giant-cell tumor. The description may be summarized as follows:

The specimen consisted of numerous pieces of tissue. There were several sheet-like fragments of dense fibrous tissue containing bone and partly covered with tumor tissue. One mass 6 × 2.5 × 1.5 cm. was cystic, with walls of pale to hemorrhagic tissue. This mass of tumor tissue contained blood-filled spaces. The tumor appeared to arise in the sacrum. The coccyx seemed to be intact.

Microscopic examination showed many small vascular spaces with intervening multinucleated giant cells scattered among closely packed cells with indistinct borders and elongated nuclei. Some of these stroma cells were large and hyperchromatic. There were scattered mitotic figures and scant intracellular material. In scattered foci there was newly formed atypical osteoid tissue as well as isolated spicules of fully developed bone. There were a few hemorrhagic fibrocellular areas which were free of giant cells. In these areas the cells were branching and mitotic figures were present. In many areas there were small accumulations of hemosiderin.

The patient was transferred to the continental United States and referred to our hospital for consideration of further treatment. The slide which he brought with him was reviewed by our pathologist and by the Army Medical Museum. Both made a diagnosis of *benign* giant-cell tumor, failing to confirm the earlier diagnosis of *malignant* giant-cell tumor.

An x-ray film of the pelvis showed the coccyx and the 4th and 5th sacral segments missing. No evidence of tumor was seen in the stump of the sacrum. The operative scar was completely healed. Physical examination and a chest film showed no evidence of metastases. The radiologist concurred in the opinion of the tumor board that, while there was no gross evidence of residual tumor, x-ray therapy should be administered in view of the statement by the operator that the tumor had been incompletely removed.

Between Oct. 6 and Oct. 18, 1944, 1,400 r were given through a single 15 × 15-cm. posterior port centered over the site of operation and including all

Fig. 3. Case 4: Anteroposterior and lateral views, showing trabeculated tumor in proximal end of tibia.

adjacent tissue. Between Nov. 20 and Dec. 4, 1,200 r additional were delivered to the same field. The daily dose was 200 r and the factors were 200 kv., added filter 0.5 mm. Cu plus 1.0 mm. Al, 18 ma., output 28.5 r/min. measured in air, 50 cm. skin-target distance, h.v.l. 0.9 mm. Cu. The total estimated tumor dose was 2,482 r. We were influenced in giving such a large dose by the fact that one pathologist had thought the tumor to be a malignant giant-cell tumor. A much smaller dose would probably have been as effective.

The patient was followed until June 1945, x-ray films being made at intervals of a few weeks to a few months. There was never any evidence of recurrence, but little or no recalcification occurred. The patient remained clinically well.

This case shows that good results can be obtained in benign giant-cell tumor by combining surgery and irradiation and that a moderate dose of x-rays is not contraindicated where no epiphyses are involved. Recalcification does not occur when the tumor has been surgically removed. Since the involved structures did not bear weight, no harm was done in this case by surgical removal. X-ray therapy was given because the operative record indicated incomplete removal of the tumor.

GIANT-CELL TUMOR OF TIBIA

CASE 4: A white male, age 29, with five months of service, was admitted to the hospital May 29, 1942. His history was not remarkable except for an injury received in June 1940, when he made a sudden stop while running bases during a baseball game and severely twisted his left knee. There were immediate pain and swelling of the knee and the patient was unable to walk for about four days. Following the injury, he experienced slight pain and swelling of the knee and proximal third of the left leg upon excessive use. There was no pain while he was at rest. Radiographic examination on June 1, 1942, showed a multilocular destructive lesion, $5 \times 6 \times 7$ cm., involving the anterior lateral aspect of the proximal end of the left tibia. There was no apparent break in the cortex. There was minimal lateral expansion at the superior margin of the lesion.

On June 3, 1942, tissue was removed for micro-

scopic examination. The marrow was replaced by cellular tissue composed of closely packed spindle-shaped cells surrounding large giant cells. The giant cells had six to sixteen nuclei and a red, fairly abundant cytoplasm. The nuclei had a distinct, large acidophilic nucleolus and there were no mitotic figures. The spindle-shaped stroma cells had a slightly smaller oval or elongated nucleus with a very small basophilic nucleolus; the cytoplasm was not distinct; the intracellular stroma was fibrillar. Scattered throughout the stroma were mononuclear, phagocytic cells containing brown pigment, undoubtedly hemosiderin. There was a moderate degree of vascularity, as indicated by numerous small endothelial lined blood vessels. These cellular structures replaced the marrow and caused considerable distortion of the bone lamellae. There were some small scattered mononuclear cells in the stroma of the tumor, probably marrow elements. In one region there was a group of large polygonal cells with characteristic vacuolated foamy cytoplasm and a small nucleus. These were modified fat or xanthoma cells. There was no evidence of malignancy. *Diagnosis:* Benign giant-cell tumor of bone.

Deep x-ray therapy was started June 9, 1942. Three ports, 10 × 14 cm., were used: anterolateral, anteromedial, and posterior. The ports were alternated, two ports being treated daily with the following factors: 200 kv., 0.5 mm. Cu plus 1 mm. Al added filtration, 20 ma., output 27.1 r per minute measured in air, 50 cm. skin-target distance, h.v.l. 0.9 mm. Cu, daily dose to each treated port 200 r. Each area received a total of 1,400 r, with an estimated tumor dose of 3,200 r.

The patient was transferred to another hospital and discharged from the service April 21, 1943. A communication from him, June 22, 1945, stated that he was symptom-free. Examination of a film made in March 1945 showed considerable recalcification at the site of the tumor and no new areas of involvement.

This case was treated before either of the authors joined the radiological branch of this hospital. While the dose was larger than is usually given, no unpleasant sequelae resulted and good-end results were obtained.

CONCLUSIONS

1. Most giant-cell tumors of bone are benign, but an appreciable number become malignant or are malignant from the outset.

2. As most cases are seen before the tumor becomes massive, there are usually no contraindications to biopsy unless the lesion is surgically inaccessible.

3. Where the tumor is proved to be of the malignant type, it should be treated surgically. If the lesion is accessible it should be entirely removed.

4. For clinical purposes the variants are considered giant-cell tumors in spite of the opinion of some pathologists that they are not true giant-cell tumors. Many variants, particularly the spindle-cell variants, are located in cancellous bone, frequently in the spine. Fortunately they are usually successfully treated by radiation.

5. Tumors which appear clinically, microscopically, and roentgenographically to be benign may be successfully treated by radiation. It is recognized that where they can be readily approached, they can also be successfully treated by surgical removal.

6. In most cases it is not necessary to combine surgery and radiation. In structures such as the spine, it seems to be a disadvantage to use curettage. Radiation alone produces calcification, which lends support to the involved area and results in an earlier cure. Cases which have been treated surgically and which recur should again be treated surgically, as they do not usually respond satisfactorily to radiation.

7. When tumors previously diagnosed as benign recur as malignant tumors, it would seem more logical to assume that the first diagnosis was incorrect than to assume that malignant changes occurred as a result of treatment, whether that treatment was surgical or radiological. There appears to be no justification for assuming that radiation as used at present induces malignant change.

8. With the comparatively small doses of x-ray used in the present-day treatment of giant-cell tumors, no damage should result to the epiphyses. A safe rule would seem to be that when there is no damage to skin and soft tissue there will be none to the epiphyses.

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DISCUSSION

J. Cash King, M.D. (Memphis, Tenn.): Dr. Bogart is to be congratulated upon his experience with giant-cell tumors, and particularly upon having collected these cases and obtained the follow-up while in military service. Reports of this type are of definite value in helping to establish the true role of roentgen therapy in the management of giant-cell tumors. It is hoped that more roentgenologists will report their results with this lesion. Because of my own limited experience, I am unable to add to the subject which Dr. Bogart has already so ably covered; but I do want to emphasize some of the points he has mentioned.

In reference to diagnosis, it still seems important that biopsies be done prior to roentgen therapy. In this way, more complete data can be compiled, which will be of value from a statistical standpoint and helpful in establishing a more uniform method of management by roentgenologists. However, for certain inaccessible lesions, treatment must be given upon a radiographic and clinical diagnosis.

As for therapy, it seems that good conservative but thorough surgical management is the treatment of choice for accessible lesions, but for the inaccessible lesions or those in which surgical management would result in some irreparable injury to other structures, roentgen therapy is certainly indicated. As for the dosage and the interval between treatments, there is little doubt that we have a comparatively wide margin of safety, but I think all of us have used doses in excess of the minimum required to obtain the maximum benefit. The response of these radiosensitive cells to roentgen therapy is surprisingly rapid for bone lesions. Therefore, it seems advisable to keep our dosage low and study carefully the effect of various intervals between treatments. Each year seems to indicate that there is much to be learned about the interval factor in irradiation therapy of all types. Dosages of from 400 to 600 r measured in air, repeated in four to six weeks and not more than three times, have given excellent results in most cases and should not produce any injury to normal structures.

I think that it is important to emphasize that the referring physician, as well as the patient, should be thoroughly informed about the delay that is to be expected before the reparative process in the destructive lesion can be demonstrable by radiographic examination following the initial roentgen therapy. In fact, they should understand that a further progression of the osteolytic process is to be expected for a period of four to eight weeks following the initial treatment, and that this finding on radiographic examination does not mean that we are dealing with

a malignant lesion or that there is not going to be a response to radiation therapy. Furthermore, though the end-result, as shown by the radiograph, is normal, strong, serviceable bone, this is of definitely different architecture from the corresponding portion of the unaffected member. These are factors also common to the surgical treatment of the neoplasm.

The recurrences that follow surgical treatment have been reported by some authors to respond poorly to roentgen therapy. I, personally, have had one such experience, but in that case the dosage used was in excess of that recommended at the present time. I think it advisable, however, to recommend continuation of surgical treatment once this form of management has been undertaken. The roentgenologist has the possibility of bringing discredit to roentgen therapy by applying it in such cases, and, if good results are obtained, the credit is usually given to surgery, rather than to irradiation.

SUMARIO

Osteomas de Células Gigantes

De un estudio de los tumores óseos de células gigantes observados en un Centro de Irradiación del Ejército de E. U. A. y de las observaciones realizadas en otras partes, sácanse las siguientes conclusiones:

La mayor parte de los osteomas de células gigantes son benignos, pero una proporción apreciable o se vuelven malignos o lo son desde el principio. Cuando tumores considerados primitivamente como benignos recurren en forma maligna, es más lógico suponer que el primer diagnóstico fué inexacto que imputar la malignidad al tratamiento. Aparentemente no hay justificación para suponer que la irradiación, en la forma en que se emplea actualmente, evoque alteraciones malignas.

Dado que la mayor parte de los casos son observados antes de que el tumor se vuelva masivo, por lo general no hay contraindicaciones a la biopsia, a menos que la lesión sea quirúrgicamente inaccesible. Cuando se comprueba que el tumor es maligno, debe tratarse quirúrgicamente. Si es accesible, debe ser excindido por completo.

A pesar de la opinión en contrario de algunos patólogos, a las supuestas variantes de estos tumores se las considera aquí puramente como tumores de células gigantes. Muchas variantes, y en particular las fusocelulares, radican en la porción reticular del hueso, y frecuentemente en el raquis, pudiendo ser por lo general tratadas con éxito por la irradiación. Varios de esos casos son comunicados en este trabajo.

Los tumores que parecen clínica, microscópica y roentgenográficamente benignos pueden ser tratados con éxito por la irradiación, y si pueden ser abordados fácilmente la intervención cruenta puede dar resultado. Por regla general, no es necesario combinar la cirugía y la radiación. En la espina dorsal el raspado parece resultar contraproducente. La irradiación, usada por sí sola, produce calcificación, la cual presta apoyo a la zona afectada y logra una curación más temprana. Las recurrencias postoperatorias no responden bien a la irradiación y deben ser tratadas con la cirugía.

Con las dosis comparativamente pequeñas de rayos X usadas en el tratamiento actualmente, las epífisis corren muy poco riesgo.

Malignant Tumors of the Small Intestine[1]

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THOUGH MALIGNANT tumors occur much more uncommonly in the small intestine than in other parts of the gastrointestinal tract, they are no longer considered so rare as in the past. As a result of renewed interest in the study of the small bowel during the past decade, they are being discovered preoperatively with increasing frequency. Roentgen examination is of prime importance in their diagnosis, and generally speaking no other method approaches it in accuracy of localization and differentiation.

Tumors of the duodenum and upper jejunum are frequently discovered during routine gastric examination, but those occurring below that level usually require a special small bowel study. Roentgen examination of the small intestine is a time-consuming procedure, demanding the utmost attention to detail. The observer must constantly bear in mind the possibility of a tumor and must be alert for the roentgen signs which indicate its presence.

The procedure varies somewhat with the individual patient, but in general is as follows. On the morning of the examination, breakfast is omitted and the patient is also requested to abstain from fluids if possible. Four ounces of barium sulfate suspended in 8 ounces of water are administered, and a fluoroscopic study of the esophagus and stomach is made, as much barium as possible being forced through into the duodenum so that a complete duodenal examination can also be accomplished at this time. Fluoroscopy is then carried out at thirty-minute intervals, and films are obtained, until all the barium has left the small bowel, except when there is evidence of obstruction, in which event the time between observations and the total examination time are determined by the motility as observed at the interval examinations. The fluoroscopic study is of the greatest value in demonstrating all of the intestinal coils and calling attention to any suspicious areas. Films are made routinely in the prone position.

Golden (4) states that he has never encountered any damage from the administration of barium sulfate by mouth in the presence of lesions of the small intestine. The small bowel contents remain fluid and can be removed by suction if necessary. A preliminary barium enema to rule out lesions of the colon is advisable in all cases with a history suggesting possible obstruction.

GENERAL CONSIDERATIONS

Pathology: Ewing (2) mentions three forms of small intestinal carcinoma: (i) a part of a local or generalized intestinal polyposis, (ii) localized adenocarcinoma with carcinomatous variations in structure, and (iii) carcinoid tumor. These tumors tend to produce various changes in the intestinal lumen depending upon their origin and mode of growth. Two principal types occur: (*a*) the constricting type, which consists essentially of a small, localized, infiltrating growth producing early mechanical obstruction by narrowing the intestinal lumen; (*b*) the fungating or polypoid type, producing a bulky mass which may project into the lumen. In the latter type there may be no destruction of the mucous membrane; obstruction is often a late occurrence and is usually due to intussusception or to the size of the tumor.

Histologically, carcinomas of the small intestine are classified under four heads: (i) adenocarcinoma; (ii) medullary carcinoma; (iii) scirrhus; (iv) colloid. Of the 34 carcinomatous tumors observed in

[1] Presented at the Second Inter-American Congress of Radiology, Havana, Cuba, Nov. 17–22, 1946.

the series upon which the present paper is based, more than 90 per cent were adenocarcinomas. The medullary type is next in incidence, while the other types are rare.

The lymphoblastomas may occur anywhere in the small intestine but show a predilection for the ileum. They usually produce a diffuse infiltration, involving one or more segments of the bowel. They are generally intramural growths and may not destroy the mucous membrane until late. Obstruction is not a striking feature and between areas of constriction there may be areas of actual dilatation.

Except for the lymphoblastomas, sarcomas of the small intestine are uncommon. When sarcoma does occur, it is usually a pure or mixed fibrous or spindle-cell type.

Argentaffine or carcinoid tumors resemble carcinoma histologically and are differentiated only by the silver impregnation method of staining, which demonstrates the presence of argentophil granules. In many instances these tumors are benign and are discovered only at autopsy, but occasional examples exhibit the characteristics of malignant neoplasms.

Clinical Picture: The rapidity of development of the clinical signs and symptoms depends largely on the location of the tumor and the degree of obstruction which it produces. There may be a history of progressive weakness and loss of weight with bowel irregularity, sometimes extending over a period of months. Varying degrees of anemia may occur, and stool examination will usually show evidence of blood.

In many cases pain is an outstanding symptom. It may be intermittent, and of a sharp, colicky nature. Its location varies with the location of the tumor. Nausea and vomiting are frequently present. Constipation is common and is the rule in those cases showing obstruction. Examination will often reveal a palpable tumor, and there may be distention, depending upon the amount of obstruction present. Evidence of peristaltic activity with gurgling and rumbling may be observed.

In general two clinical pictures are seen. In the first, the signs and symptoms are regional, dependent upon the location of the tumor and the degree of mechanical alteration in bowel function. In the second, the changes are constitutional in their effect. These clinical manifestations will be dealt with more specifically in discussing tumors of various parts of the intestine.

Roentgen Findings: The roentgen signs of tumor of the small intestine are largely those observed in tumors of other parts of the gastro-intestinal tract. Where obstruction has not taken place but there is encroachment on the lumen, either extrinsic or intrinsic, various types of deformity or filling defects, such as are seen elsewhere, will be demonstrable. The growth may be annular, producing the familiar narrowing or constriction of the bowel, usually with an accompanying dilatation of the proximal loops. In some cases there is a marginal defect or even one of central type, depending upon the point of origin and development of the tumor. In most instances where the growth has become large enough to be detected roentgenologically there will be obliteration of the mucosal pattern, even though the point of origin is in the submucosa and there is not actual invasion of the mucous membrane. Fluoroscopic examination is of great importance in visualizing the mucosal pattern of the affected area and in many instances will give the clue that differentiates tumor deformity from nontumor deformity. In certain cases the examiner is unable to determine the exact nature of the process and must be content with the diagnosis of an obstructing lesion.

TUMORS OF THE DUODENUM

Primary malignant tumors of the duodenum are relatively uncommon, but cannot be called rare. They constitute about 3 per cent of all cancers of the gastrointestinal tract. We have found the duodenum to be involved by malignant new growth more frequently than any other segment of the small bowel. Of a series of 52 proved malignant neoplasms of the

TABLE I: TUMORS OF THE SMALL INTESTINE

	Duodenum	Jejunum	Ileum	Total
Carcinoma	21	9	4	34
Lymphosarcoma	1	3	4	8
Carcinoid	..	1	3	4
Leukemia	..	1	..	1
Metastatic carcinoma	1	2	2	5
	23(44%)	16(31%)	13(25%)	52(100%)

small intestine seen in the Henry Ford Hospital (Table I), 21 were primary carcinomas of the duodenum and one a lymphosarcoma, making 42.3 per cent of the entire number. There was, in addition, one metastatic cancer. In a similar series reported by Charles Mayo (6), 26.9 per cent of the tumors were primary in the duodenum. About 90 per cent of malignant duodenal tumors prove to be adenocarcinoma. Occasionally squamous-cell or medullary carcinoma is found.

With respect to their origin, duodenal tumors have been classified by Mateer and Hartman (5) on an anatomic basis as follows: (i) supra-ampullary carcinoma, arising from the duodenal mucosa between the pylorus and the ampulla of Vater; (ii) peri-ampullary carcinoma, arising from either the papilla of Vater or the ampulla of Vater; (iii) infra-ampullary carcinoma, originating from the duodenal mucosa between the ampulla of Vater and the duodenojejunal junction. Of our series, 17 per cent were supra-ampullary, 61 per cent peri-ampullary, and 22 per cent infra-ampullary. These figures are in fairly close agreement with those of others.

The clinical picture is of considerable value in the determination of the location of the tumor in the duodenum, although a much more exact localization is obtained by roentgen study. Tumors of the supra-ampullary region often present symptoms of gastric obstruction. In the peri-ampullary group, the most common localizing sign is jaundice, which is frequently intermittent but may be continuous. Jaundice is not associated with infra-ampullary tumors, but large amounts of bile may be vomited.

Right upper quadrant pain is the most constant symptom. It may be periodic, with no relation to meals. Nausea and vomiting are frequent symptoms. Rapid and pronounced weight loss is common. In all but two of our cases the stool examination revealed evidence of occult blood. In about 50 per cent of the cases a palpable tumor is present. The liver may also be enlarged.

The roentgen findings are dependent upon the amount of deformity or constriction of the duodenum. An early tumor may escape detection if the mucosal changes are not visualized, especially in an obese patient. As the growth advances, there is usually narrowing of the duodenal lumen, with varying degrees of obstruction and dilatation of the proximal loop. This type of deformity suggests an encircling lesion. In some cases there is a characteristic filling defect produced by a more localized bulky tumor or by an ulcerative lesion in one wall of the bowel. Reverse peristalsis is common if any degree of obstruction is present. Gastric retention of varying degrees is of frequent occurrence and in some instances may lead to a mistaken diagnosis of simple pyloric obstruction. The duodenum may show an exaggerated curve downward and to the right. Displacement of the stomach upward and laterally may be a secondary pressure effect. Tumors in the distal duodenum are often large and the defects resemble those in the upper jejunum.

Sometimes no localizing defects are demonstrable roentgenologically. In some of these cases the tumor involves the papilla of Vater but has not progressed to the extent that duodenal deformity results. Of our series of 21 cases, 12 showed definite localizing defects. In 4 patients an obstructive lesion was found, with high-grade gastric retention and various atypical deformities which were not definitive as to location. The findings in 3 cases were entirely negative, and 2 patients were not examined roentgenologically. In one of these last the tumor was discovered post-mortem and in the other at operation.

CASE I: L. H., a white female, aged 55, had gastro-intestinal symptoms beginning two years prior to admission, with vomiting and abdominal distress. One year later vomiting again occurred. Black stools were frequent. There had been a weight loss of 30 pounds during the last eight months.

Physical Examination: Emaciation was prominent. The skin was yellowish. There was considerable tenderness over the upper epigastrium. The liver and spleen were not palpable.

Laboratory Examination: The hemoglobin was 61 per cent; red blood cell count 4,300,000; white blood count 6,450. Urinalysis was negative. The Wassermann reaction was negative.

Roentgen Examination: The stomach and duodenal cap were normal. In the second portion of the duodenum was an area of constriction suggesting an organic lesion, possibly malignant in origin. There was marked 6-hour gastric retention. A later examination showed an irregular filling defect suggesting a malignant lesion (Fig. 1).

Operation: Posterior gastroenterostomy was done. The patient was found to have a peri-ampullary primary carcinoma of the duodenum, with metastases in the liver and head of the pancreas.

Fig. 1. Case I: Peri-ampullary primary carcinoma of the duodenum.

TUMORS OF THE JEJUNUM AND ILEUM

Tumors of the jejunum and ileum produce a similar clinical and roentgenologic picture and will be considered together. Jejunal tumors constituted 27 per cent of our series and included 9 carcinomas, 3 lymphoblastomas, 1 case of leukemic infiltration, and 1 carcinoid tumor. In the ileum there were 4 carcinomas, 4 lymphoblastomas, and 3 carcinoids, constituting 21 per cent of the total series. Four metastatic tumors (2 of the jejunum and 2 of the ileum) were also found.

In the presence of tumors of the jejunum and ileum the clinical symptoms are those of obstruction, due either to intussusception or blocking of the intestinal lumen by the mass of new growth. Obstruction attributable to intussusception is of sudden onset with acute pain and vomiting; blood may be passed by rectum; a sausage-shaped mass is usually palpable, and the abdomen is distended. Obstruction due to encroachment of the growing tumor on the lumen produces different clinical manifestations. The onset is gradual. For several months the patient has a vague feeling of abdominal uneasiness, with belching, bloating, and some pain. As the tumor becomes more obstructive, pain assumes a more prominent place in the picture. It is frequently sharp, colicky, and intermittent. The site is the median line above and below the umbilicus. Nausea and vomiting are often late symptoms but are rather constant when obstruction is present.

Physical examination usually shows evidence of weight loss, sometimes to the point of emaciation. The most significant finding—if distention is not too great—is a palpable tumor. In other cases, when no tumor can be palpated, a sense of resistance is encountered. Tenderness is not a prominent sign.

Secondary anemia is the rule in malignant tumors of the jejunum and ileum. Stool examination is usually positive for occult blood.

A film of the abdomen may show evidence of small bowel dilatation, but this does not give exact information regarding

either the cause or location of the obstruction. During the routine small bowel study the most valuable sign is stasis of the barium due to partial or complete obstruction. This may occur in a single area or in multiple areas, as in lymphoblastoma. When the obstruction is complete, the distal end of the barium column often has a rounded or bulbous contour and the bowel proximal to it is dilated. In cases with partial obstruction small amounts of barium can be seen to trickle past the narrowed area. In some cases a typical filling defect will be demonstrable, the result of a tumor projecting into the lumen of the bowel and encroaching on the normal opening. Tumors of the mesentery and intramural tumors may produce deformity of the normal outline, with obliteration of the mucosal pattern, even though they do not actually invade and destroy the mucosa. This is due to pressure of the bulky mass.

Swenson (8) advocates decompression with the Miller-Abbott tube followed by injection of small amounts of barium. With this procedure small lesions are not obscured by overlying loops of barium-filled bowel and their location and probable nature can be more accurately determined. While this technic is undoubtedly valuable in certain cases, in many instances the routine small bowel examination will suffice.

CASE II: F. W., a white male, aged 38, complained of nausea and vomiting which had become more severe during the ten days prior to admission. He had lost 33 pounds during the past month. In the same period there had been jaundice for ten days, increasing weakness and loss of appetite. Constipation had been severe for one week.

Physical Examination: No palpable masses were present. There was no spasm or tenderness. The liver was not enlarged. Blood studies were normal. Stool examination (guaiac test) was positive for occult blood (4 plus).

Roentgen Examination: Roentgenograms of the stomach were normal. There was almost complete obstruction of the upper jejunum by a tumor. Narrowing of the lumen suggested an annular growth. There was considerable retention at the time of the six-hour examination (Fig. 2).

Operation: An annular growth was found in the jejunum about 3 feet distal to the duodenum. The proximal bowel was markedly dilated and the distal bowel collapsed. There were enlarged mesenteric lymph nodes in the vicinity of the tumor. The jejunum containing the tumor was resected together with the enlarged nodes. The pathological diagnosis was adenocarcinoma, grade II. The regional nodes showed evidence of neoplastic tissue.

Fig. 2. Case II: Annular carcinoma of the jejunum causing almost complete obstruction.

CASE III: G. A., a white male, aged 58, complained of general weakness for two months with a loss of weight of about 45 pounds. He had had some fever during the past two weeks, the temperature reaching 101° F. Diarrhea had been present for one week, but no blood had been observed in the stool.

Physical Examination: There was some rigidity in both upper quadrants of the abdomen. No palpable masses were present. The chest findings were normal.

Laboratory Examination: Blood studies showed hemoglobin 11.2 gm., red blood cells 3,600,000, white blood cells 4,900 (61 per cent polymorphonuclears, 39 per cent small lymphocytes). The urine was negative. The stool was positive for occult blood (guaiac test 4 plus); stool culture was negative for tubercle bacilli.

Roentgen Examination: The stomach was smooth in contour. The duodenal cap filled well. The duodenum and upper part of the jejunum were dilated, with a large irregular filling defect in the

Figs. 3 and 4. Case III: Leukemic lesions of the upper jejunum.

jejunum just distal to the dilatation. This suggested a tumor of the bowel causing partial obstruction (Fig. 3). There was six-hour retention in the stomach and bowel proximal to the tumor.

Operation and Subsequent Course: At laparotomy a large tumor was found in the upper jejunum and several smaller masses were palpable (Fig. 4). The section of the bowel containing the tumors was removed. Later the patient passed blood by rectum. He also vomited blood, and a generalized purpura developed. Blood studies on the last day of life showed hemoglobin 9.5 gm., red blood cells 3,230,000, white blood cells 12,800 (57 per cent polymorphonuclears, 40 per cent small lymphocytes, 3 per cent monocytes).

Necropsy: At necropsy there was evidence of myelogenous leukemia (aleukemic stage), with leukemic infiltration of the heart, liver, spleen, small intestine, adrenals, and kidneys. There was generalized purpura, with hemorrhages in the intestine.

CASE IV: A. D., a colored female, aged 46, complained, on admission, of cramping abdominal pain, nausea, and vomiting. The pain was more pronounced about two hours after meals and the attacks had recently become much more frequent and severe. There had been a weight loss of 15 pounds during recent months.

Physical Examination: Palpation disclosed a firm rounded mass, about 4 × 6 cm., in the right lower abdomen, in the para-umbilical area. There was no abdominal distention or tenderness. Blood studies were essentially normal. A guaiac test of the stool was negative.

Roentgen Examination: Small bowel studies revealed evidence of narrowing of the terminal ileum just proximal to the ileocecal valve. There was partial obstruction of the bowel, with barium remaining in the ileum proximal to the point of obstruction for more than twenty-two hours. This suggested the presence of a malignant tumor of the terminal ileum and cecum (Fig. 5).

Operation: A tumor of the terminal ileum and cecum was found. Large metastatic nodules were present in the liver. The pathological diagnosis was adenocarcinoma, grade 3.

CASE V: M. T., white female aged 40, complained of general weakness and increasing constipation relieved only by saline enemata. Generalized abdominal cramps with nausea and vomiting had appeared recently. There had been a weight loss of 20 pounds over the past year.

Physical Examination: Chest examination was negative. In the abdomen a small, hard subcutaneous nodule was palpable in the right upper quad-

Fig. 5. Case IV: Adenocarcinoma of the terminal ileum and cecum.

rant; the abdominal organs were not palpable. There was some distention.

Laboratory Examination: The stool examination showed occult blood (guaiac test 4 plus). The blood examination was negative.

Roentgen Examination: The stomach was negative. There was evidence of partial small bowel obstruction, probably in the ileum. This persisted over a 48-hour period, and the possibility of a tumor was considered (Fig. 6).

Operation: Operation revealed dilated loops of small intestine with an area of narrowing in the lower ileum, due to tumor growth. The mesenteric nodes were enlarged. Complete resection of the involved area was carried out (Fig. 7).

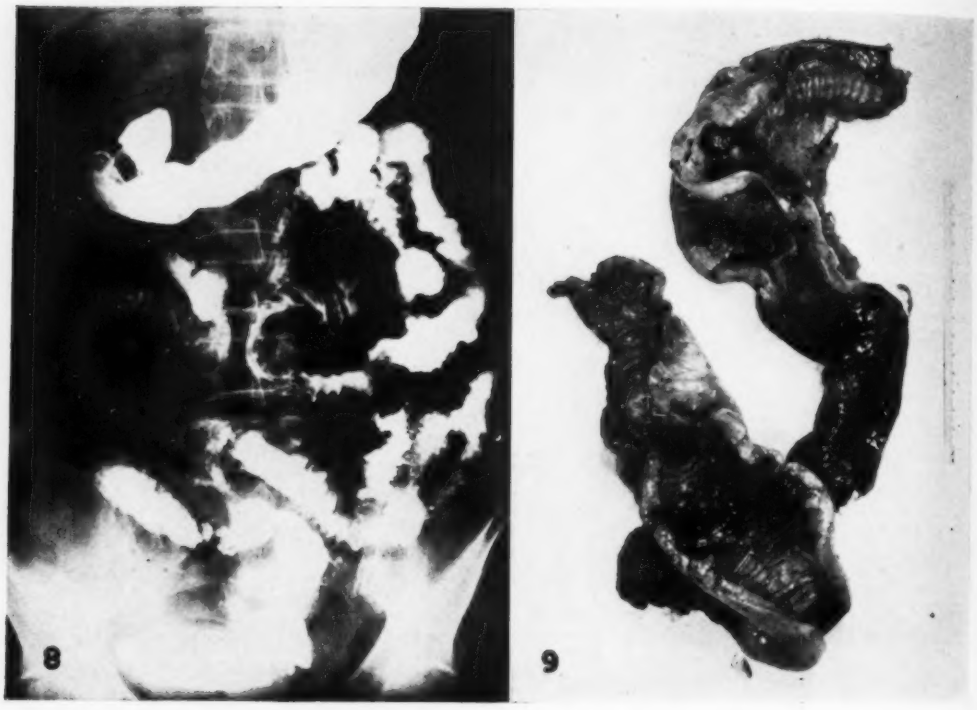
Pathological Report: Adenocarcinoma, grade 3.

Figs. 6 and 7. Case V: Adenocarcinoma of the lower ileum, causing dilatation and narrowing.

LYMPHOBLASTOMA

Lymphoblastomas are not rare, comprising about 1 per cent of all malignant gastro-intestinal tumors. There were 8, or 15.4 per cent, in our series of 52 cases. They are most common in the ileum but may occur in any of the segments of the small bowel and are frequently multiple. Males are more frequently affected. The highest incidence is in the fourth decade.

The most common complaint is vague diffuse abdominal pain, usually unrelated to food intake or bowel function. Since these tumors originate in the submucosa, they may attain large size before destroying the mucous membrane or invading the peritoneum. For this reason, hemorrhage from the bowel and peritoneal irritation may be late symptoms. There is often a change in bowel habit, with alternating diarrhea and constipation.



Figs. 8 and 9. Case VI: Lymphosarcoma of the jejunum and ileum.

Acute obstruction is not common, since the growths are rarely of the annular type. Occasionally intussusception may cause obstruction. Stasis may be due to involvement of the submucosal nerve plexus, with consequent disturbance of the autonomic nerve control of the bowel.

The types of deformity and filling defects seen on the roentgenogram are those described above. In addition, one occasionally sees a large localized dilatation of the bowel with narrowing in other areas, accompanied by partial obstruction. This is the result of ulceration combined with obstructive effects to produce an aneurysmal-like sac. This picture is characteristic of lymphosarcoma but is not common.

CASE VI: M. F., a white female, aged 62, complained of attacks of diarrhea and fever for the past seven years, with moderate abdominal pain and some bloating. The weight loss over this period was 30 pounds.

Physical Examination: A hard, somewhat tender mass was palpable in the left umbilical area. There was no general adenopathy. Stool examination was positive for occult blood (guaiac test 4 plus). Blood studies showed a mild anemia.

Roentgen Examination: The small bowel study showed an unusual mucosal picture. There were areas of deformity, with widening of the lumen in some places and narrowing in others. Some areas suggested the presence of intramural tumor and others pressure defects. The findings were suggestive of lymphoblastoma (Fig. 8).

Operation: Two areas of new growth were found: one in the jejunum and one in the ileum, in the right lower quadrant. A few enlarged mesenteric nodes were present. The involved areas were resected. The pathological diagnosis was lymphosarcoma (Fig. 9).

CARCINOID TUMORS

Attention has already been called to carcinoid tumors in the discussion on general pathology. These tumors are rather uncommon. They occurred only 4 times in our series of 52 cases (7.5 per cent). They are most frequently found in the ileum but may occur in other parts of the small intestine. In some instances

they are discovered only at operation, as non-obstructing nodules. The literature, however, contains numerous reports of carcinoids resembling other malignant tumors and metastasizing widely. Two of our patients showed definite defects roentgenologically and partial obstruction. In one case roentgen findings were negative and in one case the small bowel was not examined.

SUMMARY

The recognition of malignant tumors of the small intestine depends upon a careful evaluation of the clinical features, including laboratory studies, and, most important of all, a careful roentgen study. Much of the improvement in the recognition of these tumors has resulted from the more widespread use of serial study of the small bowel during the past decade. Newer refinements in technic can be expected still further to increase the accuracy of diagnosis.

The highest percentage of malignant neoplasms of the small bowel are adenocarcinomas. Lymphosarcomas are second in numerical order and carcinoid tumors a poor third. Grossly the tumors are of two types: constricting and fungating or polypoid. The constricting type produces mechanical obstruction by narrowing the intestinal lumen, while with the polypoid type obstruction is due to the bulk of the tumor or to intussusception.

The clinical picture is usually one of a progressive loss of weight and strength and varying degrees of anemia. Pain is a prominent symptom. A change of bowel habit is usually present and this may go on to an acute obstruction which brings the patient to seek relief. A palpable tumor is an important and significant finding. Distention is often present. Unusual peristaltic activity is common.

The roentgen picture is one which is common to the neoplasms of the gastrointestinal tract. The abnormal findings may consist of an area of narrowing of the lumen of the bowel and dilatation proximal to it. Marginal or central filling defects may also be present, with obliteration of the mucosal markings in the involved area.

Our series of 52 malignant tumors of the small intestine includes 21 carcinomas of the duodenum and 1 lymphosarcoma, or 42.3 per cent; 17 per cent of these tumors were in the supra-ampullary portion of the duodenum; 61 per cent were in the peri-ampullary portion; and 22 per cent in the infra-ampullary portion. Varying degrees of obstruction of the duodenum and stomach are commonly found associated with duodenal tumors. In the peri-ampullary type, jaundice, often of an intermittent character, is a prominent feature and is dependent on the degree of obstruction of the ampulla. Pain is the outstanding symptom. In about 50 per cent of the cases a palpable tumor is present. The roentgen signs vary from irregular constriction of the lumen with obstruction to filling defects due to a bulky tumor or an ulcerative lesion. Secondary duodenal displacement, peristaltic reversal, and gastric retention are found. Metastasis to the regional lymph nodes and nearby organs is common.

The symptoms and roentgen signs of jejunal and ileal tumors are similar. Our series included 14 primary malignant tumors in the jejunum, or 27 per cent of the total. In the ileum there were 11 primary tumors or 21 per cent of the total. In these areas the clinical syndrome is usually that of obstruction, produced either by intussusception or by tumor growth. The symptoms may be acute and constitutional in the case of intussusception or gradual in the case of a slow growing tumor. Loss of weight and strength combined with anemia and a palpable abdominal tumor are suggestive signs. The roentgen examination will usually disclose evidence of partial or complete obstruction with dilatation of the proximal bowel. A typical filling defect may be present. Mucosal alteration is present as a result of invasion or pressure defect.

In addition to the primary carcinomas, there were 5 metastatic cancers (1 in the

duodenum and 2 each in the jejunum and ileum), 10 per cent of the entire series.

Lymphosarcoma occurred 8 times in this series, representing 15.4 per cent of the total. It is most common in the ileum but may occur in any of the segments of the intestine. Acute obstruction is not common, as the growth is frequently intramural rather than intraluminal. Roentgenologically lymphosarcomas are often characterized by areas of narrowing and adjacent areas of dilatation. A characteristic aneurysmal-like localized dilatation is occasionally present.

Carcinoid or argentaffine tumors occur most commonly in the ileum and appendix but may be found in other parts of the gastro-intestinal tract. These are frequently of low-grade malignancy but may show evidence of metastasis and other signs of malignant growth. There were 4 cases in our series, 7.5 per cent of the total. In 2 of these cases there were filling defects and partial obstruction. In one case roentgen examination was negative, and in one no roentgen study was made.

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SUMARIO

Tumores Malignos del Intestino Delgado

En la serie de 52 tumores malignos del intestino delgado, estudiada, había 21 carcinomas y 1 linfosarcoma del duodeno. De las neoplasias duodenales, 17 por ciento se hallaban en la porción supra-ampular, 61 por ciento en la peri-ampular y 22 por ciento en la infra-ampular. Por lo general se asociaba con los tumores duodenales obstrucción en mayor o menor grado del duodeno y estómago. En la forma peri-ampular, la ictericia, a menudo intermitente, constituye una característica notable, dependiendo de la mayor o menor obstrucción de la ampolla de Vater. El dolor es el síntoma sobresaliente. Aproximadamente en 50 por ciento de los casos el tumor es palpable. Los signos roentgenológicos varían de constricción irregular de la luz intestinal con obstrucción a nichos debidos al volumen del tumor o a una lesión ulcerada. También se observan desplazamiento secundario del duodeno, inversión del peristaltismo y retención gástrica. Las metástasis en los ganglios linfáticos regionales y los órganos adyacentes son frecuentes.

La serie comprendía 14 cánceres primarios del yeyuno y 11 del ileon. En dichas zonas el síndrome clínico suele ser el de la obstrucción, producido bien por la invaginación o la proliferación del tumor. Los síntomas pueden ser agudos y orgánicos, tratándose de invaginación, o paulatinos si se trata de una neoplasia de desarrollo lento. La pérdida de peso y de fuerzas, combinada con anemia y un tumor abdominal palpable, son signos indicativos. El examen roentgenológico suele revelar signos de obstrucción parcial o completa con dilatación de la porción proximal del intestino. Puede existir un nicho típico. La alteración de la mucosa proviene del efecto de la invasión o presión.

Además de los carcinomas primarios, observáronse 5 metástasis cancerosas (1 en el duodeno y 2, cada uno, en el yeyuno y el ileon), representando 10 por ciento de toda la serie.

En esta serie hubo 8 linfosarcomas, siendo más frecuentes en el ileon, aunque pueden presentarse en cualquiera de los segmentos del intestino. La obstrucción aguda no es habitual, dado que el desarrollo es frecuentemente intramural más bien que intraluminal. Roentgenológicamente, los linfosarcomas caracterízanse a menudo por zonas de estenosis, adyacentes a otras de dilatación. De cuando en cuando nótase una típica dilatación localizada en forma de aneurisma.

Observáronse 4 tumores carcinoideos, en 2 de los cuales había nichos y obstrucción parcial. En un caso el examen radiológico resultó negativo y en otro no se ejecutó.

Further Observations with Intravaginal Roentgen Therapy of Cancer of the Female Pelvis[1]

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THE PURPOSE OF this paper is not to relate the successes of a new method for the roentgen treatment of carcinoma of the pelvis, but rather to discuss some of the failures of this form of therapy and to offer certain procedures with the hope of better end-results. It can be said that almost any method of treatment—radium, roentgen therapy, or surgery—will cure cancer of the cervix in the First Stage. It is in the Second, Third, and Fourth Stages of this disease that any of these methods, or all of them combined, have their percentages of failures.

The ultimate goal of the radiologist is twofold: that is, to produce a dosage of radiation uniform in distribution throughout the pelvis and of an intensity adequate for destruction of the cancer cells. It is an essential premise that the cancer cells must have a lesser resistance than the tumor bed or the surrounding tissue. The mechanical facilities for the production of such uniform dosage of radiation are available.

ANATOMY

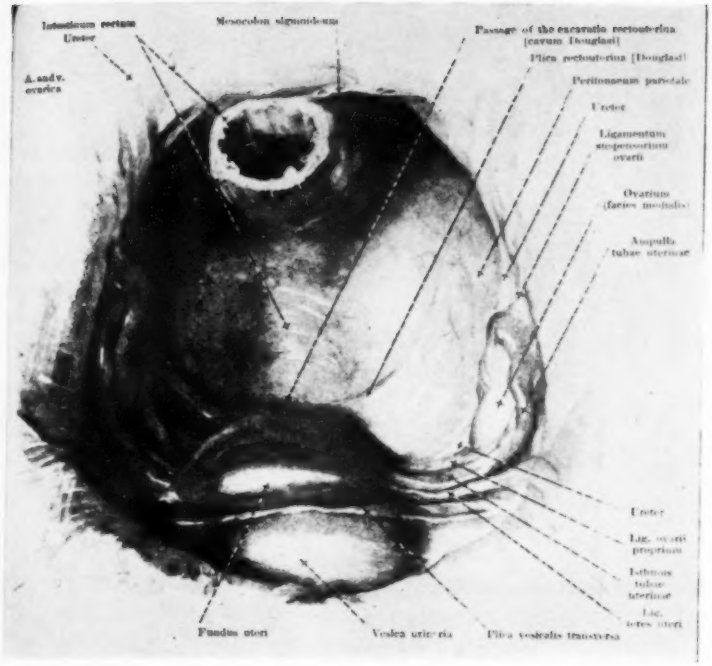
Of primary importance is an intimate knowledge of the anatomy of the female pelvis, of the sites for the beginning of cancer, and of its methods of dissemination. The anatomical structures so involved lie almost entirely within the birth canal (Fig. 1). While the canal possesses known variations in size and shape, it is in general a short cylinder, in the center of which are the bladder, uterus, and rectum and some intestinal viscera and their lymphatics, while near the outer walls are the ovaries and numerous lymph nodes (Fig. 2). Surrounding this birth canal are the bony pelvis and its muscles and ligaments, and external to the bony pelvis are the structures of the thighs, buttocks, and abdomen. It is these latter anatomical structures that distort the measurements of the female pelvis and provide a confusing obstacle to its uniform irradiation. Even in an apparently Second-Stage cancer of the cervix of a Grade III type, the cancer cells may already have passed into the lymph nodes along the lateral walls of the pelvis, and thereby account for some of the failures where the roentgen and radium therapy is inadequate in its distribution.

DIAGNOSIS

The approach to the diagnosis of cancer of the cervix and pelvis should be made with the same care and planning as that for any major surgical operation. Too often, under the pressure of a busy office or clinic, insufficient time is given to the consideration of the stage and grade of involvement and the technical procedures necessary for the destruction of the cancer. Each stage of involvement requires a different technic for the best result. No one routine technic of irradiation can be correct for all types and stages of involvement. Insufficient emphasis has been put upon this fact by many radiologists, including the authors. Cancer of the cervix so often presents itself so frankly, and the diagnosis is made so easily, that the radiologist may proceed with his treatment without due consideration of the possibility of more extensive involvement than is apparent upon the first examination.

In making the diagnosis, a careful examination of the pelvis is the first essential. As mentioned by many authors, this examination should be done with the greatest caution. Undue pressure in the manipulation of the pelvic organs is contraindicated

[1] Presented at the Thirty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–6, 1946.



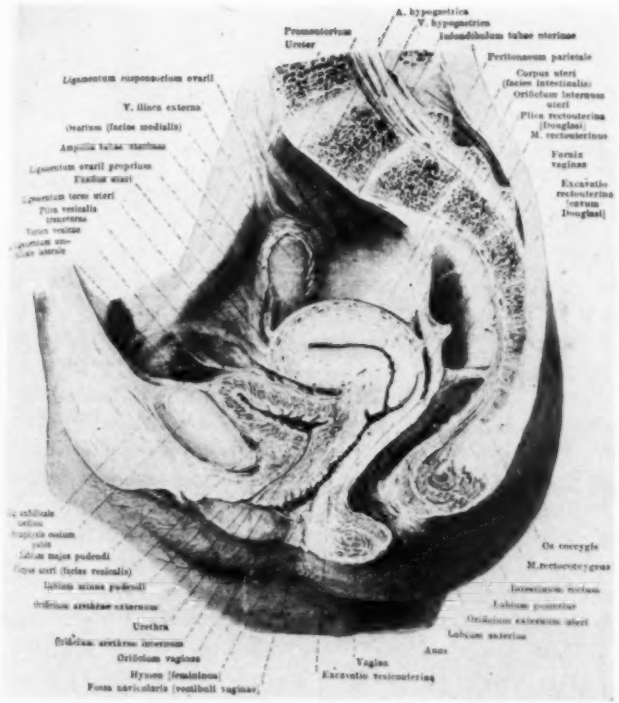


Fig. 1. Reproductions from Spalteholz showing the birth canal and the female organs.

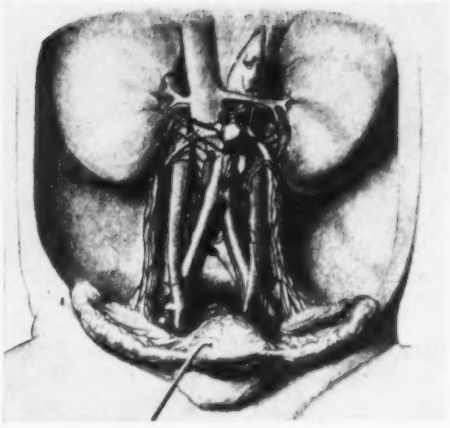


Fig. 2. Uterus, ovaries, and a few of the numerous lymphatic channels and nodes (Reproduced from Bartels).

and dangerous because of the possibility of thereby expressing the cancer cells into the lymphatic channels. For this same reason, curettements and lipiodol injections of the uterine cavity, while very essential to an accurate diagnosis of the cervical canal and uterus, must be done with the greatest care and be reserved for those cases only in which such a procedure is necessary. On the other hand, a biopsy is not only very desirable but can be done without risk to the patient. The discharge coming from the uterus and cervical canal is of the greatest diagnostic significance.[2] A purulent discharge should warn the radiologist of the probability of uterine involvement even when the cancer appears to be limited to the cervix. Constriction of the cervix with retention of the uterine secretions and subsequent enlargement of the uterus may also confuse the diagnosis. A roentgenogram of the pelvis is not of value in making a diagnosis of cancer of the female pelvis, but is useful for localization of the female organs in an obese patient. This is especially true where intravaginal roentgen therapy is to be given and uniform radiation from small cones is obligatory.

[2] The vaginal smear as developed and perfected by Papanicolaou and advocated by Meigs and R. Graham is of great value and often it is diagnostic.

TREATMENT

Having made the diagnosis as to the type of cancer, the grade and the stage of involvement,[3] the radiologist is then ready to select his method of treatment. The question of treatment is stated in this manner since there is no single routine technic applicable to all cases of cancer of the female pelvis. External irradiation with either 200 or 400 kv. is a standard procedure in all stages of involvement

Fig. 3. Roentgenogram of the female pelvis taken obliquely in the direction of the central beam for irradiatisn of the pelvis.

unless it be the First Stage of cancer of the cervix. Since the First-Stage growths are so well localized, there are those radiologists who feel that either radium or intravaginal roentgen irradiation is adequate. Surgery also should cure 100 per cent of these cases. However, there is always a possibility that the cancer is not so limited to the cervix as it seems to be upon examination, and some of the cancer cells may have passed into the deeper lymphatics, and therefore external radiation may be advisable.

The ports for treatment by external radiation may be divided into two general

[3] See Classification of the Cancer Committee of the League of Nations in Crossen, H. S. and R. J.: Operative Gynecology, St. Louis, C. V. Mosby Co., 5th Ed., 1938. Also Schmitz, Henry (1).

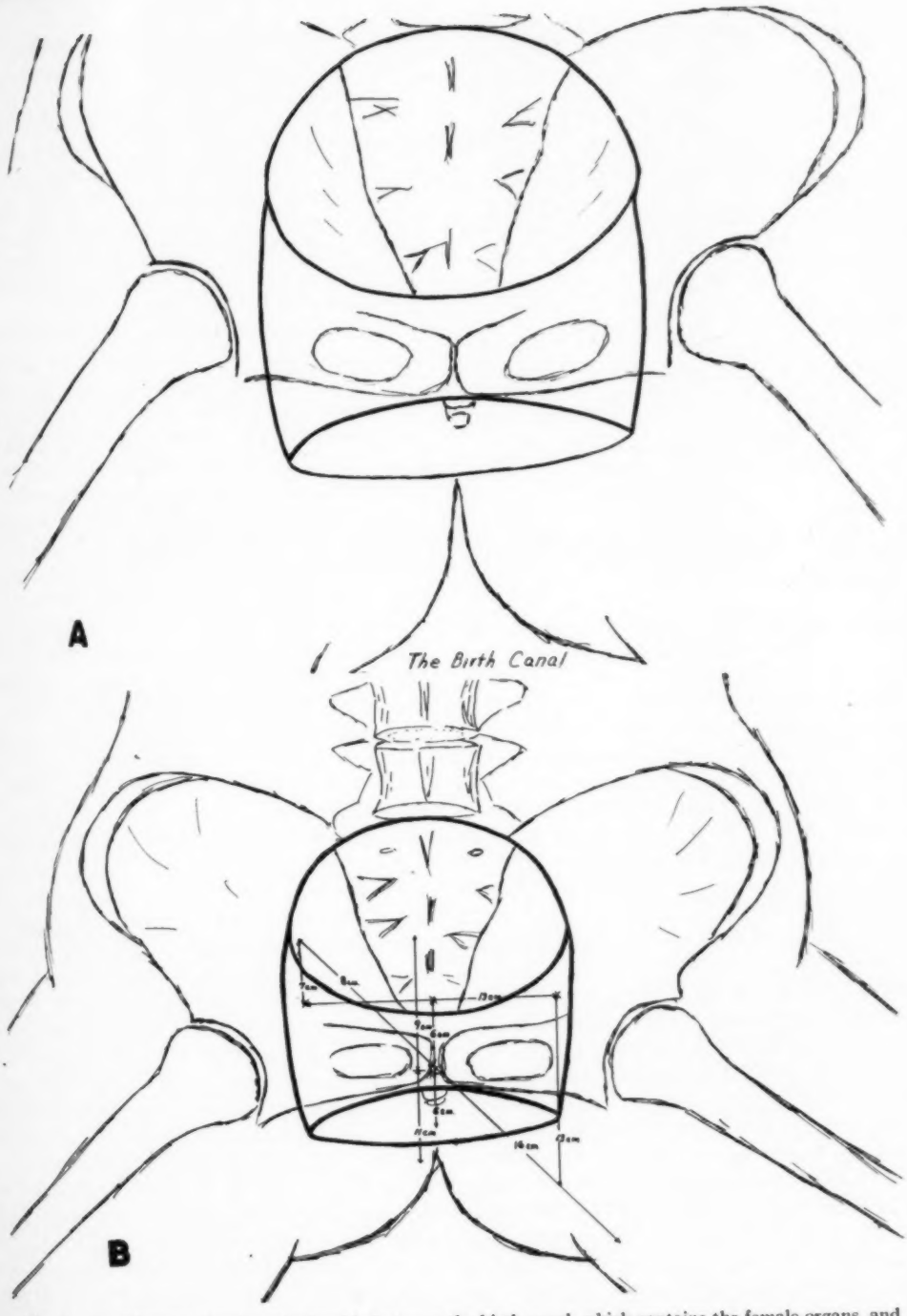


Fig. 4. A. Diagram showing relationship between the birth canal, which contains the female organs, and the surrounding structures.

B. Illustration showing the necessity of measuring each female pelvis for computing the tumor dose delivered through any one port.

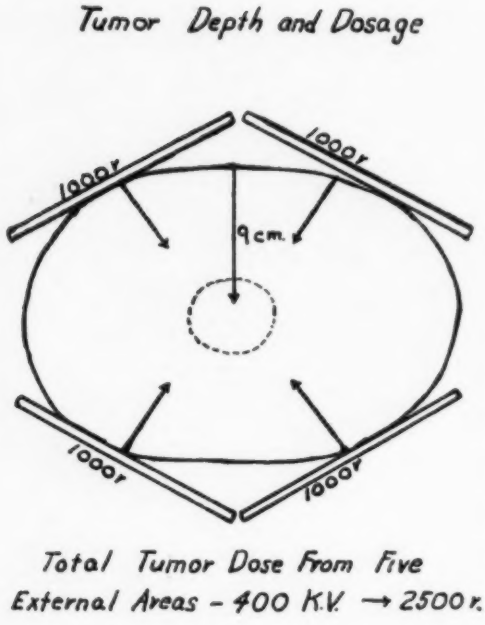


Fig. 5. Diagram illustrating four oblique ports for irradiation of the female pelvis.

classes. In the first class, are those ports in which the ray is directed anteriorly or posteriorly with one port over each lateral pelvis and perhaps one over the perineum. The objection to this method is that a larger dosage of radiation must be applied to the skin in order to have adequate radiation throughout the pelvis. Very little depth dosage is obtained from lateral ports. In the other method of external irradiation, which may be called the cross-fire method, the ray is directed obliquely through the pelvis from both right and left sides and both anteriorly and posteriorly. To these ports is added one area over the perineum. If a roentgenogram (Fig. 3) of the pelvis is made with the rays directed obliquely through the pelvis as just stated, it will be found that the birth canal and its anatomical structures are exposed to the radiation in all four positions. While this method permits some scattering of rays into the skin and superficial tissue of the side opposite the one being treated, and also a considerable exit dosage, the total radiation to the skin is considerably under that required for any permanent skin damage. It has been shown by Pendergrass and his co-workers (2) that skin damage can be expected in a significant percentage of cases where a dosage of 2,500 to 3,500 r as measured in air is given over a period of a few weeks. Such damage to the skin was the result of previous methods of treatment, in which only external irradiation was given and radium was placed within the uterus and cervical canal.

If the anatomical structures external to the birth canal were uniform in contour, then equal dosage could be given to any one of the four oblique areas with a resulting uniform dosage within the birth canal. Since this is not the case, measurements should be made obliquely through the pelvis in the line of the x-ray beam and the dosage computed according to the tissue intervening between the birth canal and the skin (Fig. 4). If this is not done, then the areas of the anterior ports may transmit adequate dosage into the anterior portions of the birth canal while those lymphatic nodes lying deep in the posterior portions of the birth canal receive an inadequate dosage because of the depth of the buttocks. Such bad results occur with involvement of the lymphatic nodes in the lateral and posterior portions of the birth canal. This can be partially offset by use of a perineal port which brings these nodes, as well as the other female organs, more directly into the path of the roentgen rays.

In the average case, 2,500 r may be delivered into the structures of the birth canal by external irradiation without approaching the limit of skin tolerance (Fig. 5). Also, this can be done so that the birth canal receives a rather uniform radiation. Since 4,000 r within the tumor cells is probably the optimal amount, there remain 1,500 r to be given either by intravaginal roentgen or radium therapy. Friedman (3) has demonstrated that a tissue dose of 4,500 r, delivered to the stomach over a period of approximately four weeks, will produce necrosis, ulceration, and, if the dose is 5,000 r or more, a large ulcer with occasional perforations. He has also

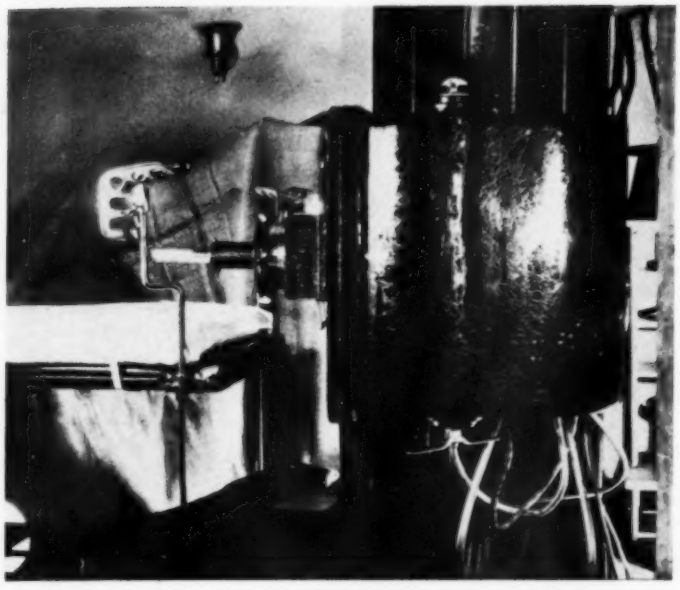


Fig. 6. Apparatus for intravaginal roentgen therapy, 200 kv.

shown that a somewhat larger dose (approximately 1,000 r more) is necessary to produce necrosis of the intestine. One of the advantages of intravaginal roentgen therapy is that it offers a greater flexibility to deliver this remaining 1,500 r either into the cervix and uterus and broad ligaments or throughout the pelvis.

For intravaginal roentgen therapy, cones (Fig. 6) are selected of a diameter suitable for the size of the vaginal canal, and multiple areas may be treated. These areas may be directed at the cervix and the surrounding structures or only at the cervix and broad ligaments. The radiologist must select the number of areas and dosage according to the case under treatment (either 140 or 200 kv. may be used). Care must be exercised, however, in placing the cone so as to avoid overlapping of the areas and the production of a delayed reaction and a lack of uniformity of radiation about the uterus, the broad ligaments, and the lymphatic nodes along the lateral pelvic walls. If the vaginal canal will admit a fairly large cone, of 3 or 3.5 cm. diameter

Fig. 7. Roentgenogram of female pelvis with intravaginal cones in the vaginal canal, with the central beam toward either ovary and the perimeter of the birth canal.

(Fig. 7), it is found that the radiation from it will cover the transverse diameter of the pelvis at the level of the uterus, provided three areas are given in the transverse

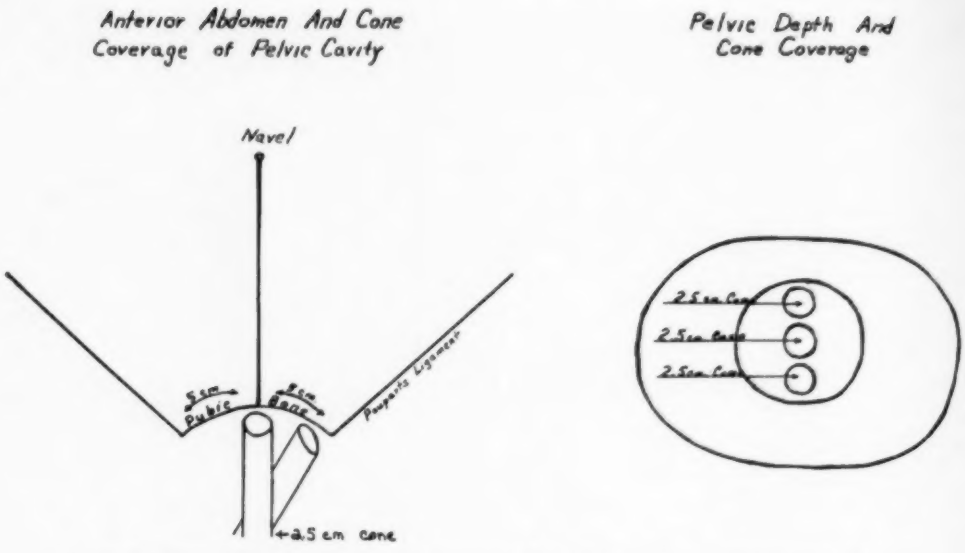


Fig. 8. Diagrams illustrating inadequate coverage of the birth canal by small intravaginal cones.

diameter, or it will cover the pelvis in the anteroposterior diameter if three areas are given in this diameter (4, 5). If a smaller cone is used, there will be a space between the areas treated which will receive very little radiation (Fig. 8). The sum of the diameters of the areas treated must equal the diameter of the birth canal. In such a case, radium may be given within the uterus to complement the intravaginal roentgen radiation, and the intravaginal radiation should then be limited to the cervix and to the nodes along the outer pelvic wall since these nodes will not receive adequate radiation from the radium within the uterus. By this method, the additional 1,500 r may be supplied through the intravaginal ports and by radium within the uterus.

Radium should be used in the uterus and perhaps in the cervical canal in all Second, Third and Fourth-Stage cases to complement the external and intravaginal roentgen therapy. This is especially true when the intravaginal cone is not large enough, even with multiple ports, to deliver adequate dosage uniformly throughout the pelvic canal (Fig. 9). In the early-stage, questionable cases in which there is a purulent discharge, radium should always be used in the cervix and uterus. The radium dosage should be computed to complement the intravaginal and external roentgen therapy.

As stated in the introduction, it is not the purpose of this paper to quote statistics of brilliant results from the use of intravaginal roentgen therapy of the female pelvis, but rather to offer a method which seems a step nearer the production of uniform radiation of the birth canal, and to point out some of the obstacles which interfere with obtaining the best results. The authors have tried larger tumor doses than 4,000 r per series of treatments, and there was delayed reaction about two months following the second series in cases in which 5,000 r tumor doses had been administered in each series. Some of these delayed reactions about the cervix and vaginal vault healed with no permanent tissue damage, but an occasional patient was not so fortunate. Therefore, it is recommended that if a tumor dose of 5,000 r is given in one series, it should not be repeated, at least in that same amount. Further studies of this tumor dosage should be made. Also, it has been observed that there is an occasional failure if the cone used in the

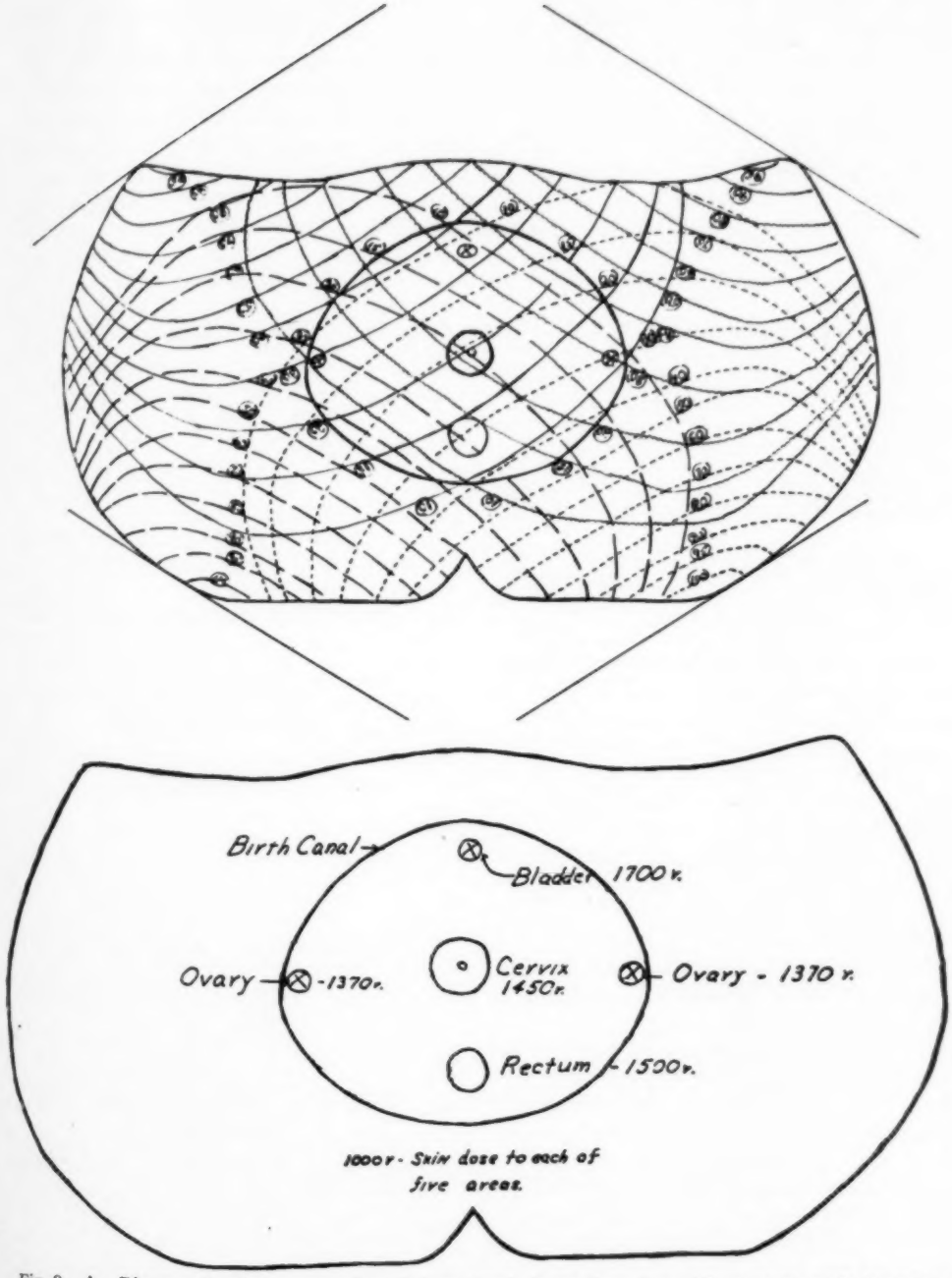


Fig. 9. A. Diagram showing computation of tissue depth dosage from four oblique ports, made by superimposing depth charts upon exact measurements of patient.
B. Diagram of patient in A, showing the tissue dose delivered into various portions of the birth canal from four oblique ports and one perineal port, with 1,000 r measured in air given over each port.

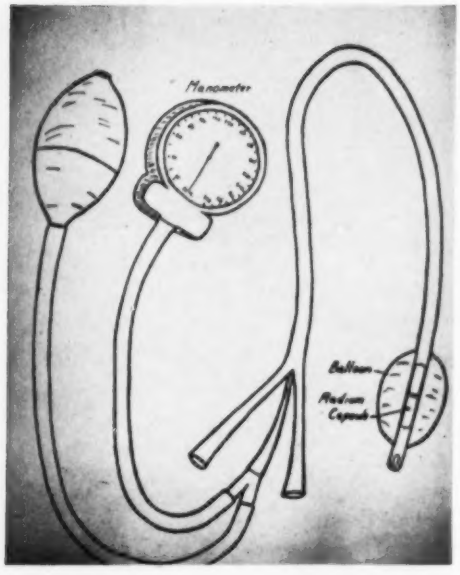


Fig. 10. Diagram of retention catheter with radium capsule inside a balloon and a manometer attached for recording the degree of inflation of the balloon.

external irradiation was not large enough to cover the lymph nodes along the lateral walls of the pelvis. With the use of intravaginal roentgen therapy there is a definite lack of damage to the skin because of the lower external radiation dosage, and less damage to the intestinal tract. The brilliant results, of course, are in the First, Second and some Third-Stage cases.

Intravaginal roentgen therapy has another application of considerable promise: namely, for residual tumors following operations upon the uterus and ovaries, or about the cecum, bladder, and rectum. It is possible to cross-fire on these residual tumors through the vagina and by external irradiation, and to obtain results which have not been possible by other methods.

Also, the authors would like to offer another use of radium where an intracavity application of it is desirable. By using a modified bladder retention catheter, the radium may be placed inside the catheter and inserted into the urinary bladder without difficulty. The balloon surrounding the radium is then inflated to the desired extent, and this degree of inflation may be recorded and controlled by a manometer (Fig. 10). The inflation removes the radium from contact with the tissue under treatment and at the same time gives greater depth and uniformity of dosage, which has been sought for some time in the treatment of tumors of the bladder and other cavities. A limited use of this method has been quite satisfactory.

SUMMARY

1. The treatment of cancer of the female pelvis is a major procedure.

2. A careful diagnosis is absolutely necessary, as is a careful selection of the method of treatment.

3. There should be adequate time for study of each case.

4. Further observations with intravaginal roentgen therapy of carcinoma of the female pelvis are presented.

5. Another method for the application of intracavity radium irradiation is presented.

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SUMARIO

Roentgenoterapia Intravaginal del Cáncer de la Pelvis

El tratamiento del cáncer de la pelvis femenina representa un procedimiento de magnitud. Hay que mostrar el mayor cuidado en el diagnóstico y otro tanto sucede

con la selección de la técnica terapéutica. Debe dedicarse tiempo al estudio adecuado de cada caso.

En la mayoría de los casos, pueden llevarse 2,500 r a los tejidos del conducto genital por irradiación externa sin aproximarse al límite de la tolerancia cutánea. Para llegar a la dosis óptima de 4,000 r, pueden administrarse otros 1,500 r por vía vaginal con rayos X o con radio. La roentgenoterapia intravaginal posee la ventaja de que su mayor flexibilidad permite llevar la dosis adicional bien al cuello y útero y ligamentos anchos o esparcirla en la pelvis. El número de zonas por tratar y las dosis respectivas tienen que ser determinados individualmente.

La roentgenoterapia intravaginal puede también utilizarse en los tumores residuales consecutivos a operaciones en el útero y ovarios y en el ciego, vejiga y recto. Menciónase la posibilidad de aplicar radio en el interior de la vejiga urinaria empleando un catéter modificado de retención.

Dosage Calculations for Various Plans of Intravaginal X-Ray Therapy[1]

JAMES F. NOLAN, M.D., and WILLIAM STANBRO, M.D.
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THE PROBLEM OF achieving a wider and yet more uniform field of irradiation in the treatment of cervical carcinoma remains an important one. The necessity for this has been emphasized before (9). Briefly it can be stated that radiation treatment methods are limited by a maximum dose which can be delivered without causing dangerous necrosis and injury, while the effectiveness of a method depends upon a minimum dose which will be lethal to all tumor cells. In the treatment of cervical carcinoma these limitations become manifest in local slough and infection in the face of over-dosage, and in recurrence and metastases in the case of under-treatment. Because of these limitations, various methods have been adopted in the hope of solving the problem of uniform radiation. Examples of these are interstitial irradiation with needles and seeds, pneumoperitoneum with external therapy, treatment through external sciatic ports, and intravaginal cone therapy. The last named is considered here.

Intravaginal x-ray therapy has been advocated for many years by Merritt, Erskine, Morrison, Bouslog, Wasson, Sante, and others. This type of therapy offers the theoretical advantages of a uniform field, good dosage, and directional control (2, 3, 4). The preliminary effect of clearing up infection in fungating lesions, facilitating radium implantation at a later date, seems obviously important (7). Also the addition of appreciable quantities of radiation to the areas lateral to the cervix, which will be supplemented later by radiation from intracavity gamma-ray emitters, is advantageous (8, 13, 15).

This study has been undertaken to compare different methods of intravaginal x-ray therapy on the basis of depth-dose calculations. Although the calculations made to accomplish these comparisons are entirely theoretical, practical considerations have limited the number of plans studied. The main treatment schemes for calculation and evaluation have been based upon experience with this type of therapy, as well as reports published by others (4, 7, 8, 11, 12, 13, 14). A discussion of the practical limitations of intravaginal therapy seems warranted here.

The larger the intravaginal port, the greater the divergence of the beam which is transmitted. A cone 4 cm. in diameter is the largest size practical, but this may not be tolerated by all patients. With the use of lubricant and an obturator, however, it is possible in most cases to introduce a cone of 3 cm. diameter without discomfort (13). Shortening the target-skin distance produces greater divergence of the beam. The use of a small tube head (as with the Phillips or Chaoul technic) which may be introduced into the vagina carries this to the maximum. Martius and Witte have achieved an almost "radium-like" local radiation field with a special tube head of this type (6). Such tubes, however, necessitate low voltages, which reduce the penetrability of the radiations. It has been found that about 30 cm. is the shortest practical target-skin distance for the usual type of x-ray equipment used in intravaginal therapy (4). All the treatment schemes studied here have been on the basis of that distance.

Greater divergence of the beam may also be achieved by shortening the target-diaphragm distance. This can be done by

[1] From the Mallinckrodt Institute of Radiology and the Department of Obstetrics and Gynecology, Washington University School of Medicine, St. Louis, Mo. Presented at the Thirty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-6, 1946.

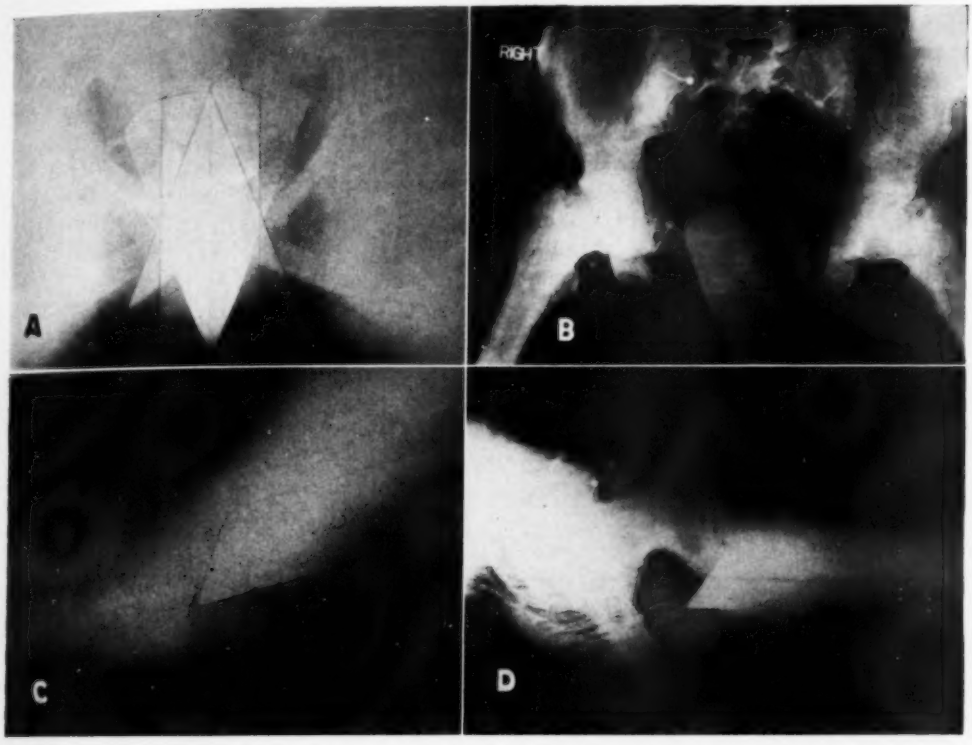


Fig. 1. A. Anteroposterior view showing pelvis of patient with 4-cm. d. treatment cone in place in three positions (triple exposure). Lateral angulation of cones measured 30°.

B. Anteroposterior view of pelvis of cadaver with 4-cm. d. treatment cone in place, angled 30° toward right side of pelvis. Position of iliac and obturator nodes and lateral pelvic wall at level of internal os of uterus marked with lead shot.

C. Lateral view of pelvis of patient with 4-cm. d. treatment cone in place, showing relation to promontory of segment.

D. Lateral view of pelvis of cadaver with 4-cm. d. treatment cone in place, showing relation to pelvic lymph nodes.

using a radio-transparent cone (7) or by the use of an expanding speculum, as described by Erskine (2). The former may not be perfectly transparent, as the peripheral portions of the beam must pass obliquely through the length of the cone wall and not only through its thickness. The expanding speculum serves to decrease the danger of over-irradiating the bladder and rectum and yet allows for maximum spread of the beam. Some value has been attached, however, to irradiating the upper vaginal mucosa in order to attack the lymphatics in that area (11). In the calculations described here, all cones were taken to be 10 cm. in length; they are indicated as radio-opaque or radio-transparent.

Further deviation of the beam toward the parametria may be achieved by lateral angulation of the tube and cone with the patient in the lithotomy position. This has been described to an extent of 15 to 17 degrees (8), but greater angulation is possible (13). The smaller the diameter of the cone, the greater the angulation which can be achieved without discomfort to the patient. With a low- to medium-voltage machine, the tube head may be rotated to a vertical position and then angulated laterally to join the treatment cone without interfering with the patient's legs. Roentgenograms of patients with cones *in situ* have shown that a lateral angulation of 30° or more can be tolerated. Films have

also been used to study the relation of commonly involved lymph nodes to intravaginal beams of radiation. The positions of the obturator and hypogastric nodes and the lateral pelvic wall were marked with lead shot in a cadaver. Cones of various diameter were placed in the vagina and angled to 30 degrees in the horizontal plane. Roentgenograms of the pelvis made in the anteroposterior diameter show that a considerable degree of angulation is necessary for the nodes to be included within the beam.

Lateral roentgenograms reveal that it is necessary to depress the perineum and aim the cone upward. This may not be possible in every instance, but the attempt should always be made to direct the beam out of the hollow of the sacrum to avoid direct irradiation of the rectum.

Various theoretical treatment plans were laid out and dosage calculations were made for their evaluation and comparison. The calculations were derived from published depth-dose tables (5,10). It is extremely difficult to obtain accurate depth-dose data experimentally with small fields of irradiation. That is because the usual instrument for measurement—the ionization chamber—must necessarily occupy some space, and the actual diameter of the chamber may represent a large percentage of the diameter of the field being explored. Measurements in the center of small beams are probably quite accurate, but those in the periphery may be inaccurate. In the present calculations, the depth dose at the periphery of the beam was considered to be one-half of the dose at the center of the beam at the same depth (10). One radiation scheme used was compared with similar ones for which measurements were made by Morrison (8) in a rice phantom and by Erskine (2) in a water phantom.

TABLE I

Calculated Depth Doses for Center of the Beam Given in Percentage of Air Dose

Quality of Radiation		HVL - 1 mm AL			HVL - 4 mm AL			HVL - .5 mm Cu			HVL - 1. mm Cu		
Factors: K.V.		100			120			140			200		
Filter		0			1.0 mm AL			0.25 mm Cu			0.5 mm Cu		
T.S.D.		30 Cm.			30 Cm.			30 Cm.			30 Cm.		
Cone Diameter (Cm.)		2	3	4	2	3	4	2	3	4	2	3	4
Depth (Cm.)	0	105%	112%	115%	108%	115%	118%	110%	115%	120%	110%	115%	120%
	1	50	60	64	78	87	92	93	100	105	100	105	105
	2	34	40	43	58	64	72	78	82	87	84	85	89
	3	22	26	30	44	50	55	64	68	71	70	71	76
	4	16	19	21	33	39	44	49	52	54	58	59	63
	5	11	13	15	25	30	34	39	44	45	44	45	52
	6	8	10	11	18	23	26	33	37	38	36	37	44
	7	6	7	8	14	18	20	25	28	30	30	32	36
	8	5	5	6	12	14	16	21	25	27	24	26	30

TABLE II

	Treatment Method								Calculated Radiation Distribution										
	Plan Number	Quality of Radiation	T.E.D Value	Diameter of Cone	Type of Cone: Radio-opaque or Radiotransparent	Lateral Angulation of the Beam	Dose per Field (Air)	Total Dose per Plan (Air)	Level of Transverse Plane Through Pelvis	Dosage in "r" at Four Points in Pelvis				Deviation from Midline in "Cm" for Three Critical Isodose Levels					
														Lateral			Antero posterior		
										Midline	2Cm Lateral to Midline	4 Cm Lateral to Midline	2 Cm A-P to Midline	15 T.E.D	7 T.E.D	4 T.E.D	15 T.E.D	7 T.E.D	4 T.E.D
	#	HVL	r	Cm.	O or T	°	r	r		r	r	r	r	Cm	Cm	Cm	Cm	Cm	Cm
One Field	I	1mm Cu	700	4	T	0°	8000	8000	Ext. Os	9600	5400	3000	5400	0	2.75	3.5	0	2.75	3.5
									Int. Os	7120	5000	2000	5000	0	2.25	3.5	0	2.25	3.5
	II	1mm Cu	700	4	T	0°	10000	10000	Ext. Os	12000	8000	5000	8000	1	3.25	3.5	1	3.25	3.5
									Int. Os	8900	6000	4000	6000	x	3.0	3.5	x	3.0	3.5
	III	1mm Cu	700	4	T	0°	12000	12000	Ext. Os	14160	10500	6000	10500	2	3.25	3.5	2	3.25	3.5
									Int. Os	10800	6100	5000	6100	x	3.75	3.5	x	3.75	3.5
	IV	1mm Cu	700	Oval 4 x 2	O	0°	12000	12000	Ext. Os	13200	9030	6000	2000	1.5	3.25	3.5	0.75	1.5	2.0
									Int. Os	7200	5700	4000	3000	x	2.75	3.5	x	1.4	1.75
Two Fields	V	1mm AL	250	4	O	20° Rt.	6000	12000	Ext. Os	6900	5000	2000	3450	3.25	4.25	4.5	0.75	0.5	2.0
				4	O	20° Lt.	6000		Int. Os	1500	2000	1600	1000	x	3.75	4.75	x	x	1.5
	VI	4mm AL	300	4	O	20° Rt.	6000	12000	Ext. Os	7080	6000	2500	3540	3.0	4.5	5.0	0.75	2.15	2.5
				4	O	20° Lt.	6000		Int. Os	2100	3500	2500	1200	x	4.75	5.5	x	1.5	2.25
	VII	5mm Cu	500	4	O	20° Rt.	6000	12000	Ext. Os	7200	6800	3000	3600	0	4.25	4.5	0	2.0	2.25
				4	O	20° Lt.	6000		Int. Os	2300	4500	3500	1500	0	4.0	5.0	0	x	0.5
	VIII	5mm Cu	500	3	T	30° Rt.	6000	12000	Ext. Os	6900	6000	2800	3450	0	3.5	4.75	0	2.25	2.5
				3	T	30° Lt.	6000		Int. Os	4920	4100	3000	2800	0	3.25	5.0	0	1.5	2.5
Three Fields	IX	5mm Cu	500	3	O	0°	4000	12000	Ext. Os	13800	5000	1000	0	1.5	2.25	3.25	1.25	1.5	2.0
				3	O	30° Rt.	4000		Int. Os	5000	4000	1500	1000	x	2.25	3.5	x	1.25	1.5
				3	O	30° Lt.	4000												
	X	5mm Cu	500	4	O	0°	4000	12000	Ext. Os	4800	4700	3500	3500	0	3.75	4.25	0	2.0	2.5
				2	O	30° Rt.	4000		Int. Os	3480	2000	2500	2000	0	x	5.0	0	x	2.25
				2	O	30° Lt.	4000												
	XI	5mm Cu	500	4	O	0°	4000	12000	Ext. Os	4800	4350	2500	3500	0	3.5	4.0	0	2.0	2.5
				3	O	30° Rt.	4000		Int. Os	3500	3500	2500	2000	0	2.0	3.75	0	0.5	2.0
				3	O	30° Lt.	4000												
	XII	5mm Cu	500	4	O	0°	4000	16000	Ext. Os	4800	7500	3500	3500	0	4.25	4.5	0	2.0	2.5
				3	O	30° Rt.	6000		Int. Os	3500	4500	3500	2000	0	4.25	5.0	0	0.5	2.0
				3	O	30° Lt.	6000												

NOTE: x indicates that the isodose line in question does not extend to the depth of the internal os.

These showed good correlation for the three sets of data at the center of the beam, but for the peripheral regions the calculated dose was lower than the measured dose. The depth-dose data used are presented in Table I.

With these values, twelve treatment schemes were explored. Diagrams were made to represent a uterus of normal size in standard relationships to the pelvic walls and adjacent viscera (1). On these, the radiation fields were laid off to scale, and calculations were made to determine the amount of radiation which would fall at certain points throughout the pelvis.

of cones, or use of radio-transparent cones; changes in the direction of the beam of radiation; and the dose applied per field, as well as the total vaginal dose for each method.

In order to compare the various plans, the right side of Table II gives the distribution of calculated doses of radiation. Two different transverse levels were chosen for

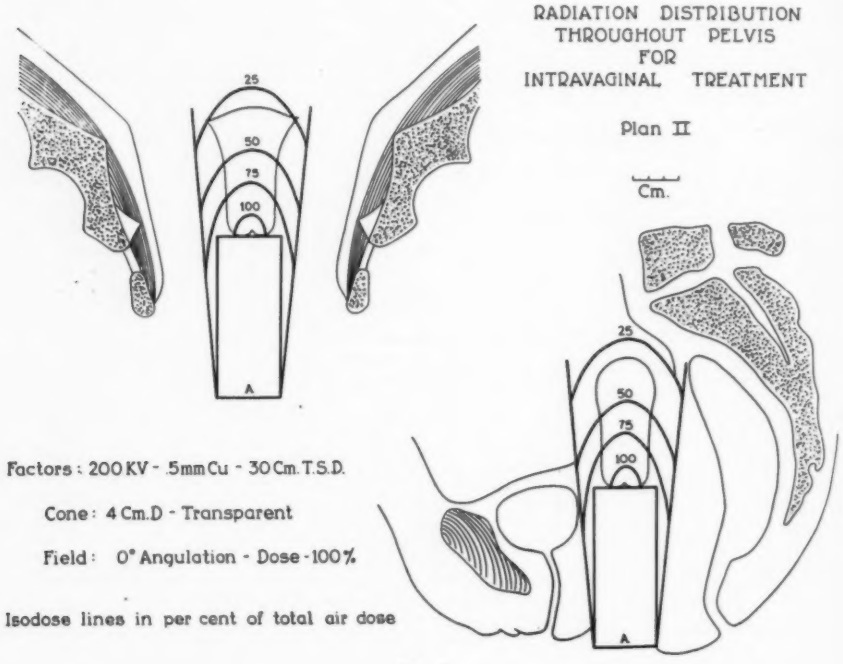
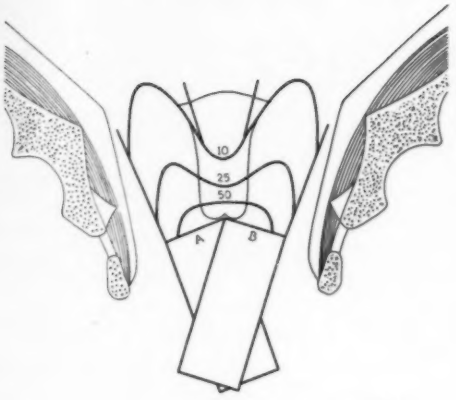


Fig. 2.

Figures 2, 3, and 4 show the distribution of radiation throughout the pelvis for treatment Plans II, VII, and XII. These are drawn so that the isodose lines represent percentages of the total dose (measured in air) delivered at the vagina by each scheme. Diagrams of this type were drawn for each of the plans studied, and from these the pertinent data were derived for comparison of the methods. The left side of Table II shows variations in the method of treatment for one-, two-, and three-field technics. The variations include changes in quality (half-value layer); alterations in size of field as determined by the internal diameter

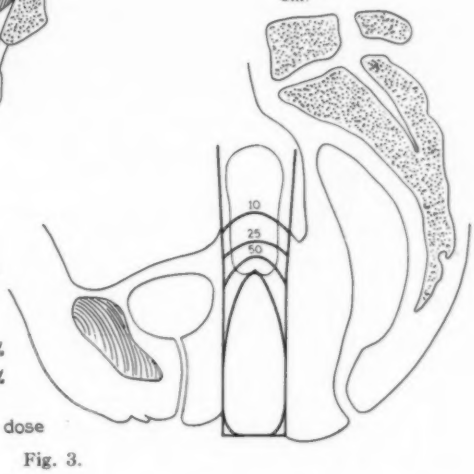
these calculations. One of these is that of the external os. The other is a transverse plane through the internal os. The number of roentgens reaching the mid-line is shown for each of the two planes in question. Other additional points were selected for calculations. Two of these are lateral to the mid-line and one is in the anterior-posterior direction. Finally, certain critical isodose levels were selected and expressed in terms of threshold doses. The distances lateral to or anterior and posterior to the mid-line, at which those amounts of radiation fell, are given in centimeters for each of the two planes considered.



RADIATION DISTRIBUTION
THROUGHOUT PELVIS
FOR
INTRAVAGINAL TREATMENT

Plan VII

Cm.



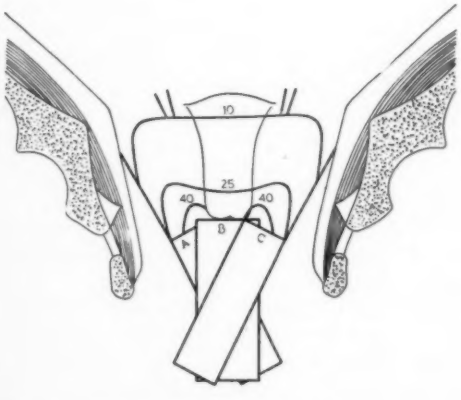
Factors: 140 KV - .25 mm Cu - 30 Cm. T.S.D.

Cone: 4 Cm. D - Opaque

Field: A - 20° Angulation - Dose - 50 %
B - 20° Angulation - Dose - 50 %

Isodose lines in per cent of total air dose

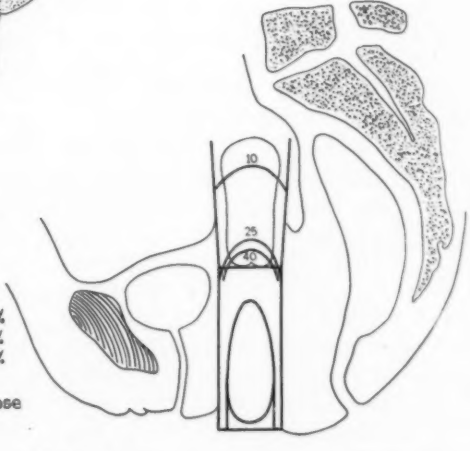
Fig. 3.



RADIATION DISTRIBUTION
THROUGHOUT PELVIS
FOR
INTRAVAGINAL TREATMENT

Plan XII

Cm.



Factors: 140 KV - .25 mm Cu - 30 Cm. T.S.D.

Cone: A - 3 Cm. D - Opaque
B - 4 Cm. D - Opaque
C - 3 Cm. D - Opaque

Field: A - 30° Angulation - Dose - 37.5 %
B - 0° Angulation - Dose - 25. %
C - 30° Angulation - Dose - 37.5 %

Isodose lines in per cent of total air dose

Fig. 4.

The transverse planes through the pelvis shown are those at the level of the external os and the internal os. The former is important because it represents the plane of limitation for intravaginal treatment methods. That is, the dosages delivered cannot be carried above those which may cause necrosis here. The plane through the internal os is important because it represents the effective plane. Here carcinoma of the cervix most often spreads laterally by direct extension or through lymphatics. The dosages delivered here should be kept below those which might cause necrosis and yet lie in the range that will control tumor cells.

Because of the fact that threshold erythema doses represent rather extensive assumptions so far as biological reaction is concerned (16), the actual roentgens at certain points in the pelvis are presented. These exclude any variability of biological reaction with quality of radiation, but are accurate for comparing radiation schemes of the same quality. The points taken are those at the mid-line, 2 cm. lateral and 2 cm. anteroposterior to the mid-line, and 4 cm. lateral to the mid-line. These four points in the two planes indicated represent the areas most important in this type of therapy.

The critical isodose levels chosen are those of 15, 7, and 4 threshold erythema doses. These are considered as being indicative of definite biological reactions (1). Doses of 15 T.E.D. or above may cause tissue necrosis and detrimental effects. Doses from 7 to 15 T.E.D. are adequate for tumor control without causing necrosis of normal tissue. Doses of 4 to 7 T.E.D. are less than adequate, but are important because they may reinforce radiation delivered through other treatment ports.

The first section of Table II describes four treatment plans which utilize one field centered on the cervix. For these, a quality of radiation which would yield good penetration was assumed and a transparent cone of the largest possible diameter was simulated. The first three plans were prepared to show the effect of variation of dose, and the fourth was calculated to find the effect of a shaped cone.

Fom the table one can see that, as dose is increased, the depth dose also increases. Treatment schemes for such a method have been used and advocated for a total of from 7,000 to 8,000 r (air) (8). Plan I represents this scheme at 8,000 r; no necrosing dosages appear, but the depth dose lateral to the internal os is not great. Plan II, for which 10,000 r (air) is calculated, shows a small area of possible necrosis but probably could be used. Because of the area of probable necrosis in Plan III, in which 12,000 r (air) is simulated, it would be unwise to carry the dosage thus far if the assumptions made as to predicted biological reaction are correct. Plan IV shows the results from an oval cone (4 × 2 cm.) with the dose carried to 12,000 r. Such a plan might protect the area of the vesicovaginal and rectovaginal septa and yet allow lateral spread of the beam (4). The cone simulated is opaque. The figures indicate that this plan yields about the same results as Plan II (a circular cone for 10,000 r) lateral to the mid-line and appreciably less in the anteroposterior direction. From these data, we may conclude that such one-field treatment plans with circular transparent cones are limited to a dosage level of 8,000 to 10,000 r in air and that the area of effective radiation extends for about 3 cm. from the mid-line at the level of the internal os.

The second section of Table II is presented to show the effects when the higher-voltage radiations are sacrificed to achieve a greater angulation of the beam by lateral direction of the cone (13, 15). The first three schemes utilize an opaque cone of 4 cm. diameter, with an angulation of 20 degrees in the horizontal plane. Different qualities of x-rays are compared, the total dose delivered being kept at 12,000 r or 6,000 r per field. As the quality of radiation is increased, the penetrability is also increased, so that the dose reaching the deeper tissues becomes greater. If we consider it possible to translate the roentgens delivered into T.E.D., we find that 12,000

r is too much for the softer types of radiations, as fairly wide areas of probable necrosis are indicated. However, radiation of 0.5 mm. Cu h.v.l. (140 kv., 25 mm. Cu filter) yields no area of necrosis because of its higher value per T.E.D.

The fourth scheme in this group utilizes a smaller cone (3 cm. diameter), of transparent type, and a wider angulation (30° instead of 20°). The quality of radiation is the same as in Plan III. With this plan the amount of radiation is not so great at the points indicated as with the larger opaque cone angulated to a lesser degree.

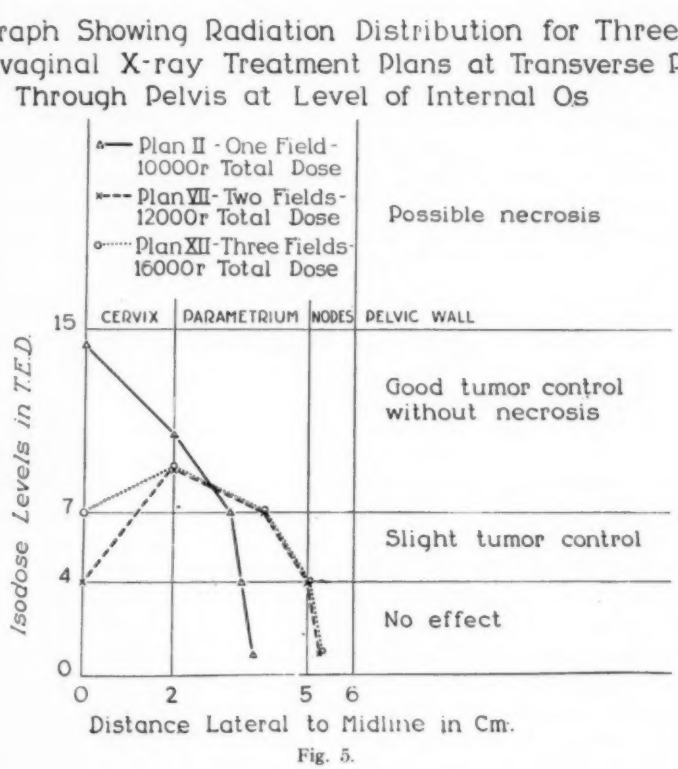


Fig. 5.

The third section of Table II presents the data from four plans of treatment which utilize one straight cone and two angulated ones (13). For the first three, the quality, dose, and angulation are kept constant; but the size and position of the cones are varied. Plan IX calls for three cones of 3 cm. diameter with the lateral ones angulated at the mid-point of the cervix. Plan X utilizes a large central cone (4 cm. diameter) with the lateral ones, of only 2 cm. diameter, placed in the fornices and angulated at the lateral edge of the cervix. Plan XI uses a large central cone 4 cm. in diameter, with two lateral cones 3 cm. in diameter angulated at a position 1 cm. lateral to the external os. Studying the table, one sees that the overlapping of Plan IX may be dangerous and that the spreading out of the cones, as in Plan X, does not yield very effective radiation at the level of the internal os. Plan XII is essentially the same as Plan XI except that the dose delivered by each lateral cone is increased to 6,000 r (or 37.5 per cent of the total) and that the central cone remains at 4,000 r (25 per cent of the total). Even with this increase, there will probably be no necrosis,

and this redistribution of the doses yields a much more effective spread of radiation at the level of the internal os.

In order to compare the one-, two-, and three-field schemes which could be used without danger according to these calculations, Figure 5 was prepared. This graph indicates various isodose levels and their possible biological effect on one co-ordinate and the position of those isodoses lateral to the mid-line at the level of the internal os on the other co-ordinate. Plan II, which is a one-field scheme carried to 10,000 r, shows no necrosis in the cervix at the level of the internal os, but a sharp fall in the amount of radiation in the area of the parametrium. Plan XII, which is a three-field method carried to 16,000 r, increases the effective radiation in the cervix itself but maintains the lateral spread of Plan VII.

One must be careful in drawing conclusions from a work of this sort that is based entirely on calculations, which admittedly may not be basically absolute. We must reiterate that the factors taken to translate the calculated figures into a common denominator, which would indicate expected biological reaction, may be inexact. Furthermore, the stylized treatment plans considered here could hardly be duplicated under actual treatment conditions in all patients. Distortion and fixation of the vaginal walls may interfere with insertion of vaginal cones. If, however, one considers the shape of the radiation distribution curves which have been prepared for these comparisons, and not the numerical results, one finds that certain concepts are borne out. These concepts are important in the consideration of this type of therapy from a clinical point of view. These may be discussed as follows:

(1) The one-field treatment plan with optimum physical factors is limited, so far as dosage is concerned, by the reaction at the level of the external os, which represents the portal of entry. The field of radiation is essentially similar to that from an intracervical tandem plus colpostat arrangement for radium. Such a one-field treatment method does not provide enough energy to the lateral parametria to control growing cancer cells even when the amount of radiation delivered at the portal of entry is carried to its maximum. The method could well be used, however, at a lower dosage as a preliminary to radium implantation. This would bring about the effects of primary regression and control of infection mentioned before. In cases of carcinoma of the cervical stump, where radium implantation is difficult, this method would perhaps provide a better field of radiation.

(2) The two-field method of irradiation is obviously inadequate for the control of tumor cells confined to the cervix itself. If, however, one considers the isodose shape for such a treatment method, and those for a combination of intracervical tandem and interstitial needles (9), one is struck by the idea that they would well complement one another. The facts that the intravaginal cones contribute their greatest dose at the vaginal mucosa, and the long radium sources contribute theirs at the midportion of their lengths, result in a spatial separation of the portals of entry or limiting points so far as maximum dose is concerned. It is quite conceivable that, with a combination of these two types of therapy, the energy delivered by each could be kept below the level that would cause dangerous necrosis, and yet more effective radiation would be delivered throughout the pelvis than with one of the methods alone. Since the energies of the x-rays considered in the present calculations are so different from gamma radiations, no attempt has been made here to predict the biological reactions which would result from such a combined treatment method.

(3) The radiation distribution for the three-field method of treatment would seem to be as effective as that obtained from intracavitary or interstitial radium applications. Intravaginal roentgen treatment carried to its maximum limit could be used without radium.

(4) The most promising concept that this study teaches us is that considerable variations of treatment methods are possible, and effective amounts of energy may

be delivered to tumors through the intravaginal ports. The addition of this method to one's armamentarium permits greater individualization of treatment methods. From such procedures an improvement in clinical results is to be expected.

SUMMARY

1. The distributions of radiation for twelve practical plans of intravaginal x-ray therapy were calculated from published depth-dose data.

2. The effects of variation in size, shape, type, direction, and combination of cones were studied.

3. The variations in radiation distribution were evaluated upon the basis of roentgens delivered to certain points in the pelvis and also upon the basis of expected biological response.

4. Conclusions are drawn from these studies that intravaginal cone therapy may well be a useful tool in the treatment of carcinoma of the cervix. Within its limitations it can be expected to contribute to better results in the treatment of cervical cancer by irradiation methods.

ACKNOWLEDGMENT: The authors wish to express their appreciation to Dr. E. H. Quimby of the College of Physicians and Surgeons, Columbia University, New York City, for her generous aid and advice in the determination of the basic depth-dose values used in this study. They also wish to thank Miss Elizabeth Ley of the Mallinckrodt Institute of Radiology, Washington University, St. Louis, Mo., for the preparation of the diagrams and tables.

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DISCUSSION

(Papers by W. W. Wasson and J. F. Nolan and Wm. Stanbro)

Arthur W. Erskine, M.D. (Cedar Rapids, Iowa): It has now been demonstrated theoretically, experimentally, and clinically that the most effective means of destroying the primary tumor in cancer of the cervix is by the direct application of x-rays (the so-called transvaginal or intravaginal method). The chief objection to the method is the difficulty of exposing a sufficiently large field. The great advantage of the multiple-field method is that a large area can be exposed through a small introitus. For example, if the introitus will only admit a speculum with a circumference of 12 cm., it is possible to expose a total area 7.5 cm. by 6.4 cm., as shown in Figure 1. (This is not the way Dr. Wasson does it, but it could be done this way and I selected this position of the five fields since they expose a rectangular field, which is desirable because it ensures adequate dosage to the lateral vaginal fornices, and since they show maximum overlapping.) This is a much larger field than can be adequately exposed by any other method through such a small introitus.

An objection which might be made to the use of overlapping fields is that they produce inequality of distribution. In order to talk intelligently about this I had some measurements made with the chamber at the points A, B, C, D, and E, as indicated on Figure 1. The results are shown in Tables I and II. For Table I the chamber was barely submerged. For Table II it was

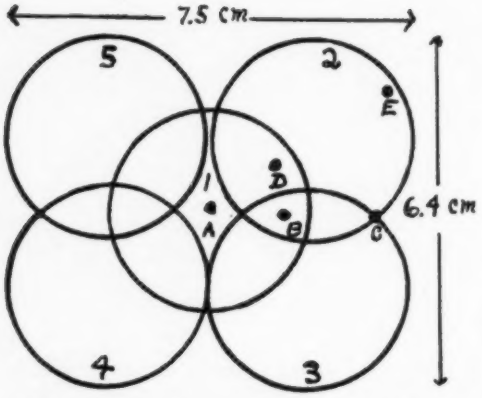

Fig. 1. Diagram showing size of total field exposed by five overlapping fields 3.75 cm. in diameter. Letters indicate points at which tissue dose was measured.

TABLE I: TISSUE DOSE AT SURFACE PER 100 R (measured in air) TO EACH OF FIVE FIELDS*

Position of Chamber	1	2	3	4	5	Total
A	118.0	31.5	31.5	31.5	31.5	244.0
B	106.0	106.0	106.0	19.5	19.5	357.0
C	39.0	98.5	98.5	19.5	19.5	275.0
D	110.0	110.0	31.5	19.5	19.5	290.5
E	39.0	110.0	31.5	19.5	19.5	219.5

* 200 kv.; 35 cm. A.S.D.; filter 0.5 mm. Cu.; h.v.l. 0.9 mm. Cu; diameter of circular fields, 3.75 cm.

submerged to a distance of 3 cm. In both cases 100 r as measured in air was given to each of the five fields without moving the chamber. The following factors were used: 200 kv., 20 ma., copper filter 0.5 mm., 35 cm. anode-skin distance, h.v.l. 0.9 mm. copper; diameter of circular fields 3.75 cm.

In Table I you might expect point B to receive three times the dose received at point A, because it lies within the circumference of three fields. What actually happens, as shown on the first line of the table, is that the 100 r given to point A (measured in air) is increased by back-scatter to 118; but point A also receives about 31 r from each of the surrounding fields, so that the total tissue dose to point A is 244 r. Point B receives 106 r from each of the fields 1, 2, and 3, but only 19.5 r by scattering from fields 4 and 5, so that the total is only 357 r. The differential between the maximum and minimum dose received at any part of the surface is small (the ratio being about three to two). The reasons are scattering and the fact that the dose at the edge of the field is much smaller than it is in the center because of the excessive diaphragming.

TABLE II: TISSUE DOSE AT 3 CM. DEPTH PER 100 R (measured in air) TO EACH OF FIVE FIELDS*

Position of Chamber	1	2	3	4	5	Total
A	86.5	43.5	43.5	43.5	43.5	260.5
B	71.0	71.0	71.0	23.5	23.5	260.0
C	62.0	79.0	79.0	15.5	15.5	251.0
D	86.5	86.5	19.5	15.5	19.5	227.5
E	62.0	79.0	31.0	15.5	31.0	218.5

* 200 kv., 35 cm. A.S.D.; filter 0.5 mm. Cu.; h.v.l. 0.9 mm. Cu; diameter of circular fields, 3.75 cm.

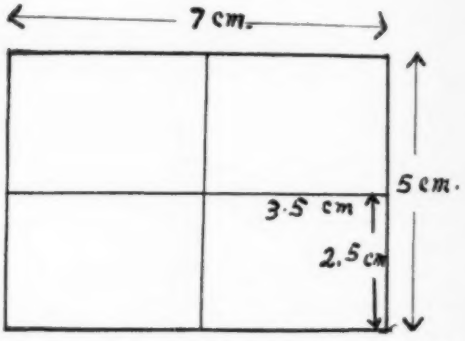

Fig. 2. Diagram showing four adjacent rectangular fields.

Table II shows a surprisingly large total depth dose percentage because scattering is at a maximum at a depth of 3 cm., with this hardness. The surface dose at point C, which is just at the edge of the fields at the surface is 275 r, but the depth dose is 251 r because, due to the divergence of the beams, the point then lies well within the circumference of the two beams. The large depth dose undoubtedly explains the frequency of proctitis. It might be better to use somewhat softer rays, possibly with a h.v.l. of about 0.5 mm. copper; this hardness produces maximum back-scatter.

It is now possible to obtain tubing of any required shape for the periscopic intracavitary cone. I suggest that somebody try experimentally four oblong fields. If the introitus will only admit a speculum with a circumference of 12 cm., one could use a rectangular tube 2.5 × 3.5 cm. If four fields could be accurately exposed, as shown in Figure 2, it would be possible to treat a total field 5 × 7 cm. There would, of course, be some danger of overlapping the four fields, as shown in Figure 3, which would produce an overexposure of the central centimeter but, with care and the use of the periscope, this danger would be minimized. Even though the fields were overlapped so that the central centimeter received four exposures, the ratio between the maximum and minimum dose would not be more than two to one.

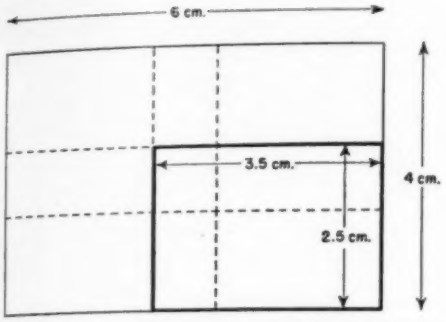

Fig. 3. Diagram showing four overlapping rectangular fields.

It is apparent that there is now a great deal of interest in the transvaginal method and that many, perhaps most, of you will soon be using it. Those of us who have been using one or another modification of the method for several years would indeed be remiss in our duty if we failed to point out *now* some of the pitfalls that have beset us and to urge you to control your initial enthusiasm, to make complete examinations and careful classifications, to keep decent records, and above all to avoid the dangers of over-dosage, which, as Dr. Wasson has pointed out, are real.

Finally, this rather elementary study of scattering and distribution of the x-rays used in a technic something like the one used by Dr. Wasson justifies the following conclusions:

1. The distribution over the entire combined field both at the surface and at a depth of 3 cm. is nearly enough uniform, and is especially good at the edges of a rectangular field.

2. The depth dose percentage at 3 cm. is higher than it needs to be.

3. Softer rays produced by lowering the voltage, or preferably by using less filter, would be better (theoretically).

4. Diminishing the depth-dose percentage by shortening the anode-skin distance as well as using softer rays would, theoretically at least, improve the method.

5. The possibilities of exposing four adjacent rectangular fields should be explored, first by laboratory experimentation, and, if the results justify it, clinically.

Axel N. Arneson, M.D. (St. Louis, Mo): From the program at this meeting, as well as from private discussions, it is evident that there is great interest in intravaginal treatment with x-rays. That interest has been stimulated by Dr. Wasson, Dr. Erskine, and many others. It has been my good fortune several times to discuss with Dr. Nolan the problems in his paper. At the outset it may appear that he has presented complicated data. He has used complicated data to explore different possibilities for intravaginal x-rays. The result has been a contribution toward simplifying procedures that can be used.

The usefulness of intravaginal x-rays can best be shown on the basis of clinical results. To be sure, the amounts applied intravaginally must be correlated and integrated with x-rays administered externally, and with radium applied to the cervix and uterus. We have in intravaginal x-ray therapy an added tool for increasing materially the amount of radiation falling upon the cervix itself. The rate of administration can be varied over a wide latitude. It has been pointed out that we may expect better regression and more favorable control of infection. It is also obvious that intravaginal x-rays can be used to increase the effective radiation throughout the tumor-bearing region.

Mention should also be made of additional uses for intravaginal x-rays. Various types of lesions occur within the vagina. Some are primary, and others are metastatic from cervical or from corpus cancer.

Both essayists are to be congratulated. It is wholesome to see work directed toward exploring different possibilities for this method of treatment.

Dr. H. J. Ullmann, M.D. (Santa Barbara, Calif.): I would like to ask Dr. Nolan, first, if this 16,000 r is the tissue dose in the region of the cervix or parametrium. I want to get it clear whether he referred to the surface dose of all ports added together or whether he referred to a true tissue dose. I also want to inquire, whether, where this dose has been given, he adds radium. I am not sure that I heard whether or not this was done.

I want to add one point to the discussion, and I feel very strongly about it. It is that no one should gain the impression from these papers that cancer of the cervix can be treated at a kilovoltage of 140 or less. One should not treat cancer of the cervix with equipment limited to less than 200 kilovolts. For portions of the treatment where 140 kv. is indicated, this is available with the same machine, but one should not be limited to 140.

Harry H. Bowing, M.D. (Rochester, Minn.): My chief interest in this technic concerns the adequate treatment of the involved peripheral lymph nodes in cases of carcinoma of the cervix. For example, the primary lesion of an average stage 3 carcinoma of the cervix can be rather promptly controlled by intracavitary radium therapy and supplemental roentgen therapy; however, the control of the involved peripheral lymph nodes remains a problem for the therapeutic radiologist. The various methods of intravaginal roentgen therapy may furnish an additional port of entry for roentgen rays and thus increase the total depth dose.

I hope these workers will extend their interest in obtaining, if they can, an increased depth dose in the fields of peripheral node involvement.

J. A. del Regato, M.D. (Columbia, Mo.): I am glad to be able to participate in the discussion of this very important subject. I would like to point out that the dosage calculations of Drs. Nolan and Stanbro are based on consideration of transvaginal roentgen therapy alone. They have shown that with the use of a large speculum the irradiation is greater in the mid-line and that it rapidly decreases toward the wall. This would imply a condemnation of the use of this type of transvaginal roentgen therapy in favor of the use of smaller metal cylinders directed to cover alternatively both sides of the pelvis and the cervix.

One can, of course, irradiate the parametria and even the pelvic wall with the use of a narrow transvaginal beam, but the argument is that such approach would not achieve a homogeneous irradiation of the diseased area, nor a sufficient one. One cannot accurately include an entire carcinomatous parametrium in a narrow beam of radiation 3 cm. in diameter. We consider this a futile attempt without precision.

The success of radiotherapy of cancer depends on the ability to distribute a necessary minimum of radiations as homogeneously as possible throughout the tumor area in order to diminish the untoward effects on the normal structures. In the treatment of carcinoma of the cervix, this cannot be accomplished with external irradiation alone (with 200 kv.), and an internal treatment is necessary as a complementary phase. Hence, transvaginal roentgen therapy should be used to assure its best possible adaptation to the external pelvic irradiation. We think that this is best accomplished with the use of a large speculum with transparent walls. We have treated over 200 consecutive cases of carcinoma of the cervix by transvaginal roentgen therapy following external irradiation; in no case was it necessary to use a speculum less than 3.6 cm. in diameter. Our field opens to a circle 6 cm. in diameter at the level of the cervix and consequently assures irradiation of fornices and part of the parametria; our speculum provides protection for the vulva and also for the bladder and rectum, if it is indicated.

I would like to congratulate Drs. Nolan and Stanbro on their serious attempt to evaluate the different methods of transvaginal roentgen therapy, but I would like to re-emphasize that any such attempt would have to consider their value in association with the external irradiation of which they are intended to be a complement.

Dr. Wasson (*closing*): I wish to thank the discussants, and to express my appreciation of Dr. Nolan's calculations and those of Dr. Erskine. The final technic which ultimately will be worked out will result from the investigations of such men as Dr. Nolan and Dr. Erskine.

What I presented to you were clinical observations, and I said nothing about results. I do want to stress certain points very briefly. First, in regard to diagnosis, and second, selection of method. Let us not distort our perspective so that we see only one method of treatment; it may be surgery; it may be radium; it may be intravaginal x-rays; or it may be a combination of all of them.

Now just a word with regard to the radiation dosage. The interest shown here creates in my mind a little fear that we may overdo the dosage of radiation, and that we may throw disrepute on a fairly good method, for I have found that it is easy to get an over-dosage by the intravaginal method. The r's, you know, slip in there so easily that it is astonishing. And I have had delayed results; I have had delayed necrosis some two months after the second series. I have found that when we go to a 5,000- or 6,000-r tumor dose—I repeat, *tumor dose*—then it is wise to be careful about its repetition—*very careful* about its repetition. Again, in regard to tumor dose, we should calculate the dosage from each cone, and not add the r output from all the cones together and consider that the tumor dose.

Today, apparatus is becoming more readily available to us, and one of these days, I think, we will have tubes that will give us a greater r output, so we will be able to give this treatment adequately and rather quickly.

Dr. Nolan (*closing*): There have been several questions raised which have to do with the relationship of the calculations performed and their clinical application. Such questions as, "Why were simulated doses presented for total plans of treatment rather than for each field (as is the more accurate and accepted manner)?" and "Are additional external x-rays and intracervical radium advocated?" indicate need for further explanation.

We must reiterate that this work was done in order to explore the possibilities of intravaginal x-ray therapy alone. The technics of calculation necessitated certain set conditions in the placement of each cone in relationship with the geography of the upper vagina. We admit that in practice this accuracy cannot be obtained and there may well be overlapping of the fields and reirradiation of folds of vaginal mucosa which are not displaced from the beam. However, in order to simplify each stylized treatment plan for purposes of comparison, the doses assumed were designated by the amount to which the upper vagina was exposed in the whole treatment scheme. These doses were taken as air measurements. In clinical application, it is necessary to individualize each treatment scheme and to regulate the actual exposures by observation of the reactions to each treatment.

As far as additional methods of irradiation are concerned, no attempt was made in these calculations to add the effect of external x-rays or inter-

cervical radium. Clinically it would be unwise to depend on this or any other single treatment method, since results from a combination of treatment methods are usually superior in a wider range of patients. We have made no brief for the exclusion of other treatment methods in favor of intravaginal x-rays, although in some clinics external and intravaginal x-rays are advocated instead of external x-rays and intracavity radium. In our own experience we have found that intravaginal x-rays may be combined with other methods of treatment (external x-rays plus intracervical and parametrial radium) to yield impressive preliminary results.

SUMARIO

Cálculo de la Dosis en la Roentgenoterapia Intravaginal

Tomando los datos publicados acerca de profundidad-dosis se calculó la distribución de la irradiación con doce planes factibles de roentgenoterapia intravaginal, con uno, dos y tres campos.

Estudiáronse los efectos de la variación en tamaño, forma, tipo, dirección y combinación de conos.

Avaluáronse las variaciones en la distribución de la radiación, tomando por base los roentgens entregados en ciertos puntos de la pelvis y también la respuesta biológica esperada.

El concepto derivado de este estudio que más promete es que es posible introducir considerables variaciones en las técnicas terapéuticas, y que pueden llevarse a los tumores dosis efectivas de energía por vías intravaginales. La adición de esta técnica al arsenal disponible permite una individualización mayor del tratamiento y debe conducir a un mejoramiento de los resultados clínicos.

Diverticula of the Foregut[1]

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EMBRYOLOGICALLY, the foregut is defined as being that part of the gastrointestinal tract which is proximal to the ampulla of Vater. In other words, the foregut includes the pharynx, the oesophagus, the stomach, and the duodenum. The distal inch of the oesophagus, the stomach, and the duodenum are supplied by the coeliac axis.

The workers of the Medical Faculty of the University of Manitoba have always shown an interest in diverticula. Grant (1), while Professor of Anatomy, published the first of his studies on duodenal diverticula, based on cadaver material. MacLean (2) was one of the early operators and was the first to remove a pouch imbedded in the head of the pancreas. The writer (3) has presented two papers dealing with the radiological aspects, the last report being in 1935.

Since 1935, as our experience has increased, we have observed a not inconsiderable number of diverticula of the foregut. The great majority of them have been incidental findings in routine barium examinations. Those at the oesophageal-pharyngeal junction and some of the oesophagus have been demonstrated as the result of an examination specifically directed to that part. The frequent demonstration of these lesions by our group is perhaps attributable to the fact that we are "diverticula conscious."

Despite the large number of papers, many of recent date, dealing with these diverticula, there still exists considerable confusion as to their classification, cause, and clinical importance. The descriptive term used by one author has apparently an entirely different meaning when used by a second. Odgers (4) divides all diverticula into primary and secondary and I consider this to be the simplest and the best classification. The primary diverticula are those which occur without obvious cause. Their walls are formed by the mucosal and submucosal coats. Secondary diverticula are those having an obvious cause, with walls consisting of all coats of the bowel.

Synonymous terms used by various authors for primary diverticula are "false" and "congenital"; for secondary diverticula, "true" and "acquired." The terms "pulsion" and "traction," as applied to diverticula, only confuse the issue, as it makes little if any difference clinically whether the sac has been pushed out or pulled out.

I shall consider diverticula in the following order: (i) oesophageal-pharyngeal diverticula; (ii) diverticula of the thoracic oesophagus; (iii) diverticula of the stomach; (iv) duodenal diverticula.

OESOPHAGEAL-PHARYNGEAL DIVERTICULA

Raven (5) has presented an excellent study on oesophageal-pharyngeal diverticula and I am indebted to him for the anatomical details. These diverticula are usually situated posteriorly. They have been erroneously described as oesophageal. Actually the pouch is a prolapse of the pharyngeal mucous membrane between the two different sets of musculature comprising the cricopharyngeus. This muscle is composed of an upper superficial constrictor portion, which is part of the main pharyngeal constrictor musculature and derives its nerve supply from the pharyngeal plexus. The rest of the cricopharyngeus is composed of a lower, deeper sphincteric muscle, which blends posteriorly with the musculature of the oesophagus, forming a strong sphincter, and is innervated by several small branches from the inner

[1] From the Department of Radiology, University of Manitoba. Presented at the Second Inter-American Congress of Radiology, Havana, Cuba, Nov. 17–22, 1946.

Fig. 1. Small oesophageal-pharyngeal diverticulum.

division of the recurrent laryngeal nerve. Herniation of the pharyngeal mucosa occurs between these muscles, which differ from each other in their innervation, physiologically, and morphologically.

In the early stage of the development of a pouch of this nature, symptoms are referable to derangement of the sphincteric operation of the cricopharyngeus, and the patient complains of mild dysphagia. This dysphagia may be present for a long time before a pouch is fully formed. In this early stage there is spasm of the strong sphincter guarding the oesophageal orifice; consequently, two divisions of the cricopharyngeus become separated, and the pharyngeal mucosa commences to herniate in the interval that is formed. Figure 1 illustrates a very early, and therefore small, diverticulum.

When the pouch is fully formed, symptoms are dysphagia, audible gurgling due to the displacement of air in the pouch, excessive salivation, and regurgitation of unaltered particles of food. At a later stage a large pouch causes marked constriction of the upper end of the oesophagus by direct pressure. There is pronounced dysphagia for solids and liquids. The oesophageal orifice is much distorted. Figure 2 illustrates a large diverticulum.

The demonstration of these pouches is usually a very simple radiological procedure. In the last two years we have seen 22 of these in our practice, an incidence of 0.11 per cent. They are not a medical rarity.

DIVERTICULA OF THE THORACIC OESOPHAGUS

Diverticula of the oesophagus are usually seen immediately below the bifurcation of the trachea and in the lower two inches. To those situated below the bifurcation of the trachea Kragh (6) gave the name "tuberculous pouch." This term

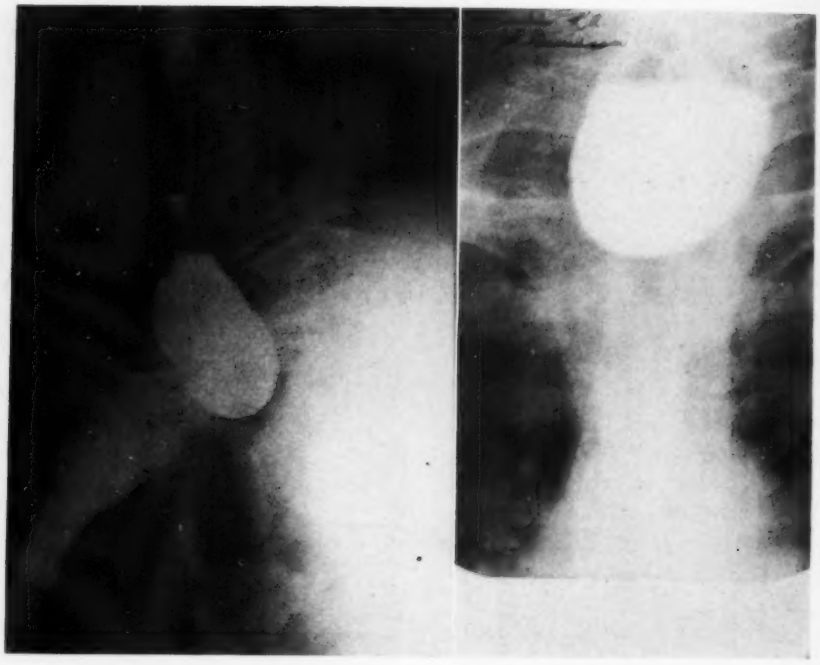


Fig. 2. Large oesophageal-pharyngeal diverticulum

is unfortunate. It is quite true that a number of these diverticula are seen in association with a tuberculous lymphadenitis, but many occur in patients in whom tuberculosis does not exist. The pouches are small and conical in shape with an oval orifice, and the long axis of the pouch runs obliquely upwards or downwards. The wall of the pouch often shows much irregularity. These diverticula may be single or multiple. We have seen 6 examples in the last two years. They have been found in the course of some 20,000 routine barium examinations, an incidence of 0.03 per cent. Figure 3 illustrates the radiological appearance.

In the same series, 3 cases of diverticula of the lower end of the oesophagus have been observed, an incidence of 0.015 per cent. It is said that a history of cardiospasm can usually be elicited in these cases, but such a history was obtained in only one of our cases. The pouch is usually fusiform. Figure 4 illustrates a diverticulum in this position. In this particular case, though the lesion was an incidental finding and the patient had no symptoms referable to it, the hand of the surgeon could not be restrained.

DIVERTICULA OF THE STOMACH

Our incidence of diverticulum of the stomach is 0.1 per cent, a somewhat lower figure than that recorded by other authors as reported by Frank (7). These diverticula have all been found at the cardiac end of the stomach on the lesser curvature.

The symptomatology is quite inconclusive. Indeed, it is doubtful if any complaints at all can be explained on the basis of these diverticula. It is emphasized that they are an incidental finding in the radiological examination. Figure 5 demonstrates a diverticulum of the stomach.

DIVERTICULA OF THE DUODENUM

Grant, in his study of cadaver material, showed a percentage incidence of 11.3 for duodenal diverticula. This is higher than

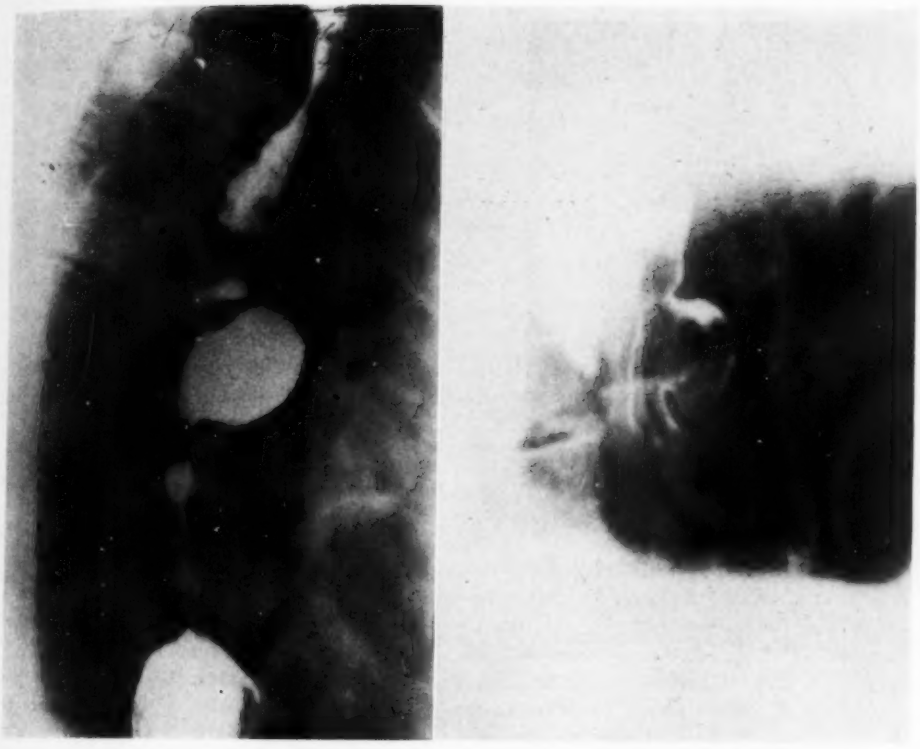


Fig. 3. Diverticulum of the thoracic oesophagus.

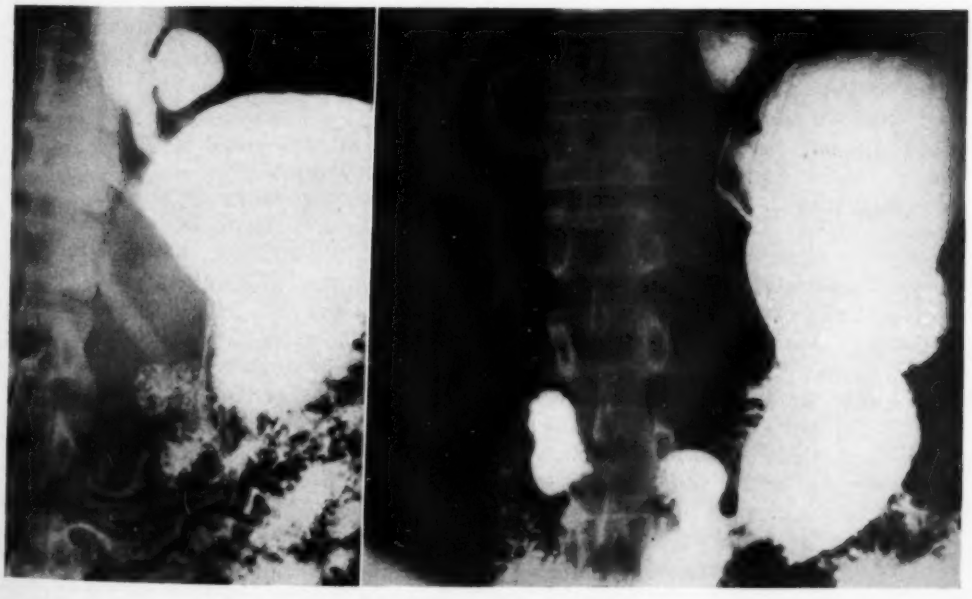


Fig. 4. Diverticulum of the lower oesophagus.

Fig. 5. Diverticulum of the stomach.

the percentage 1.42, quoted by Baldwin, and 3.3, quoted by Linsmayer. In considering the frequency of diverticula as demonstrated by x-ray examination, we encounter a wide variation in percentages. One would not expect so high a percentage as is found in cadaver material for two reasons. First, the age incidence of the cadaver group would certainly be higher than the age incidence of the patients presenting themselves for routine gastro-intestinal examinations. Secondly, it is obvious that to fill a duodenum with paraffin and then to open the duodenum and search for pouches is a more accurate and certain method than visualization with the aid of an opaque medium. Case (8), in a series of 6,847 consecutive barium meal studies, demonstrated duodenal diverticula in 1.2 per cent of cases, Andrews' (9) percentage was 0.18, and that of Spriggs and Marxer (10) 3.8. Our incidence as determined by reviewing the reports on the last 20,000 barium series is 5.1 per cent. This is somewhat lower than the incidence previously reported when a smaller series was reviewed. It is pointed out that in the compilation of these statistics only diverticula of the primary type were considered, that is to say, those arising from the second, third, and fourth portions of the duodenum. No case of secondary diverticulum, pouching of the duodenal cap, the result of stenosis due to an ulcer, has been included.

Included in our group of primary diverticula of the duodenal loop are diverticula of all sizes, some very small, no larger than a pea, and some very large. A number of the diverticula arise adjacent to the ampulla of Vater. Care has been taken not to include dilatation of the ampulla as a diverticulum. It is again pointed out that secondary diverticula have not been included in the study.

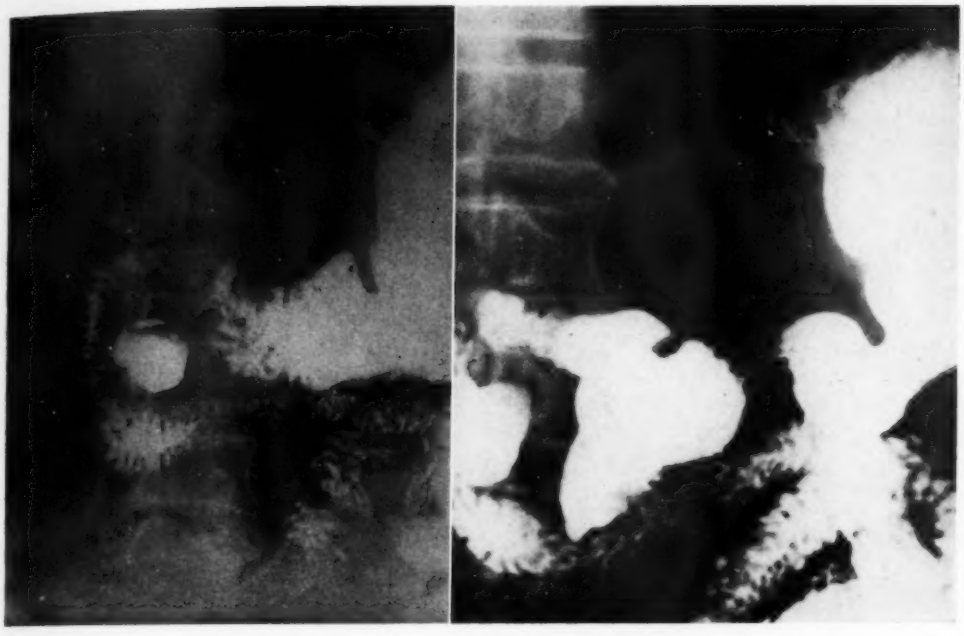
Primary diverticula of the duodenum have the following characteristics:

1. They are found only in the second, third, and fourth portions of the duodenum.
2. They are found on the inside of the duodenal loop and are therefore in relationship to the head of the pancreas.
3. They are often multiple. They are often seen as goblet-shaped protrusions of the mucous membrane, communicating with the lumen of the duodenum by a narrow neck.
4. They vary in size from that of a small pea to that of a walnut.
5. They are more frequently seen after the fifth decade.

Figures 6 and 7 demonstrate diverticula of the duodenum.

One would expect considerable pathological disturbance to be associated with duodenal diverticula, both because of their frequently large size and because they are situated on the inside of the duodenal loop. Here they may produce stenosis of the duodenum, affect the bile ducts, or irritate the pancreas. The absence of inflammatory processes is probably due to (*a*) sterility of the duodenal contents; (*b*) the retroperitoneal position which allows for their distention; (*c*) free drainage back into the bowel.

Despite the frequency of these diverticula and the fact that they are often very large, it is surprising how infrequently



Figs. 6 and 7. Two examples of duodenal diverticula.

any symptoms can be attributed to them. No complete case of obstruction of the ducts of the pancreas or liver is on record, and only in some cases has a partial obstruction been noted. It would appear that the important considerations are the imbedding of the diverticulum in the pancreas and the presence or absence of free drainage. When these diverticula give trouble, it is usually because of inflammation of the wall, which is of extremely rare occurrence.

CONCLUSIONS

1. Diverticula of the different portions of the foregut have been described and illustrated.

2. The incidence of the various diverticula is given.

3. With the exception of the diverticula at the pharyngeal-oesophageal junction, they are usually incidental findings.

4. The oesophageal-pharyngeal diverticula produce definite symptoms. The others are practically asymptomatic.

5. Diverticula of the lower oesophagus are important when instrumentation is contemplated.

6. Because diverticula are so readily demonstrated by x-ray, their significance, except for the oesophageal-pharyngeal type, has been greatly exaggerated.

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SUMARIO

Divertículos del Prozogáster

Bajo el título anterior considéranse divertículos esófago-faríngeos y divertículos de la porción torácica del esófago, del estómago y el duodeno. En una serie de 20,000 exámenes corrientes con bario, ejecutados durante los dos últimos años, la incidencia de los varios divertículos fué: divertículos esófago-faríngeos, 0.11 por ciento; divertículos de la porción torácica del esófago, precisamente más abajo de la bifurcación de la tráquea, 0.03 por ciento, y en el extremo inferior del esófago, 0.015 por ciento; divertículos gástricos, 0.1 por ciento; divertículos duodenales, 5.1 por ciento.

Por virtud de la facilidad con que se descubren roentgenográficamente, se ha exagerado sobremanera la importancia de los divertículos del prozogáster. La forma esófago-faríngea puede ocasionar disfagia, sialorrea y regurgitación alimenticia. Los demás suelen ser asintómáticos, encontrándosesólo fortuitamente al efectuar exámenes corrientes.

Medical, Biological and Industrial Applications of Monochromatic Radiography and Microradiography[1]

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CERTAINLY THERE is nothing new in the idea of using an x-ray beam of essentially a single wave length (monochromatic) in contrast with the usual beam of many wave lengths (polychromatic) in the various branches of radiography, including roentgen diagnosis. In the high state of development of this science in the hands of roentgenologists to the point of delineation of extraordinarily fine detail, the question is naturally asked, what is to be gained? It seems of interest to give an account of a renewed experience of several years, particularly during the war, with monochromatic radiography. For this subject crops up anew as the result of a newly developed microradiography, in which radiographs of small objects are photographically enlarged up to 300 or 400 diameters. Therein lies the critical test of monochromatic *vs.* polychromatic technic.

A brief review of the principles of x-ray spectroscopy will suffice as a basis for consideration of monochromatic radiography.

1. At all voltages and with x-ray tube targets of all chemical elements, a general or continuous spectrum characterizes the radiation generated. It is only above a certain critical voltage that the characteristic line spectrum of the target element is generated. Thus, at all voltages below 69,300, the tungsten target tube generates in the range of shortest wave lengths only the continuous or polychromatic beam with a short wave-length limit, λ_0, determined by the voltage in accordance with the Duane-Hunt application of the Planck-Einstein equation or $Ve = hc/\lambda_0$, where V is the voltage, e the electronic charge, h the Planck quantum constant, and c the velocity of light. Above 69,300 volts there appear the K-lines of the characteristic tungsten spectrum superposed on the continuous spectrum, with the result, of course, that certain wave lengths, particularly the $K\alpha_1$ line at 0.2086 A.U. are greatly intensified. The much softer rays of the L, M, N series are generated at correspondingly lower voltages.

To isolate this characteristic $K\alpha_1$ ray would be to produce a monochromatic beam. There is only one way of accomplishing this strictly, and that is selection and reflection by a crystal, but the very great loss in energy renders the method impracticable. The more common practice is use of a characteristic filter, for which the K absorption edge lies between $K\beta$ and $K\alpha$, cutting out the shorter rays, including $K\gamma$ and $K\beta$, but transmitting the $K\alpha$ doublet and all longer rays. This process is also impracticable for tungsten rays, because of the high intensity of the general radiation at 70,000 volts and above, and because of the fact that some exceedingly rare element such as lutecium or ytterbium is required for the filter. Thus the attempt to isolate a single wave length from the tungsten rays is confronted with almost insurmountable obstacles, not only from a practical standpoint, but even for purely academic experimentation. For considerable penetration and for relatively thick sections in the practice of radiography, it is still essential to use the highly complex polychromatic beam from the usual tungsten target.

X-ray diffraction analysts have long been familiar with and made use of tubes which do, however, produce essentially monochromatic beams. For example, a molybdenum target will generate the very intense characteristic K-rays at 20,000

[1] Presented at the Thirty-second Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–6, 1946.

volts, where the general radiation is still very weak. When filtered through a very thin layer of a zirconium compound with no serious loss in intensity, the tremendously predominating Kα doublet characterizes the beam as essentially "dichromatic," with a wave length of 0.71 A.U. Similarly other commonly available diffraction tubes have the following targets listed in comparison with those just discussed (see Table I).

TABLE I

Target	K Series Excitation Voltage	Predominating Wave Length ($K\alpha_1$ Doublet)	Filter
Tungsten	69,300	0.21 A.U.	?
Molybdenum	20,000	0.71 A.U.	Zirconium
Copper	8,860	1.54	Nickel
Cobalt	7,710	1.79	Iron
Iron	7,100	1.93	Manganese
Chromium	5,980	2.286	Vanadium

It is clear, therefore, that such tubes operated below 50,000 volts produce beams so nearly of known predominating wave lengths that the whole science of diffraction analysis from sharp line patterns has been made possible; and the lower the voltage the farther from general radiation and the nearer the approach to a monochromatic beam such as would be isolated perfectly only with the crystal spectrometer. Therefore, the application to radiography is necessarily limited to thin sections.

2. What, then, is the theoretical advantage of monochromatic radiation?

Radiographic detection of inhomogeneities in an object depends upon a difference in absorption of x-radiation by different portions of the object. The most heavily absorbing regions of the object placed between the x-ray tube and the photographic film decrease the intensity of radiation reaching the film and lead to a lower photographic density of the film under that region.

The absorption of x-radiation follows the equation

$$I = I_0 e^{-\mu x}$$

where I is the intensity of radiation of initial intensity I_0, after passage through x centimeters of homogeneous material, e is the base of natural logarithms, and μ is the linear absorption coefficient. Differences in absorption of x-rays in various parts of an object may arise either from different values of the absorption coefficient or from variations in thickness of material in the different parts.

Values of the mass absorption coefficient μ/ρ (where ρ is the density) for different elements as a function of the wave length of the x-rays absorbed have been determined. The mass absorption coefficient is a function of atomic number and for a given element increases with an increase in wave length of the x-rays absorbed. The data listed in Table II for aluminum as absorber will illustrate this variation.

TABLE II

Wave Length of X-radiation, A. U.	Mass Absorption Coefficient for Aluminum
0.5604	2.74
0.6149	3.60
0.7097	5.30
1.5392	48.7
1.6565	58.4
1.9344	92.8
2.2869	149

The laws of absorption apply to single wave lengths as demonstrated in Figure 1 for the Kα rays of molybdenum, copper, and cobalt, commonly used as targets. It is self-evident that there must be the sharpest delineation of radiographic detail with a monochromatic beam properly selected. Three photographic properties must be considered in a radiographic method, namely, contrast or sensitivity, latitude, and definition. Assuming not too wide a range of thicknesses, contrast and definition are of greatest importance.

It now becomes significant to compare the performance of a tungsten and a molybdenum target tube, both operated at 40,000 volts and with identical radiographic technics as to size of focal spot, distance from focal spot to specimen and of specimen to film, identical film, and simultaneous development.

In order to compare the contrast obtainable with the two types of x-ray tubes, radiographs were made of an aluminum step wedge. This wedge was constructed of strips of aluminum 0.010 in. thick. Ten of these strips of successively shorter length were combined to give a wedge consisting of ten steps covering the thickness range of 0.010–0.100 in. of aluminum. The wedge was masked with lead to eliminate scattered radiation, and a lead foil 0.010 in. thick was placed behind the film.

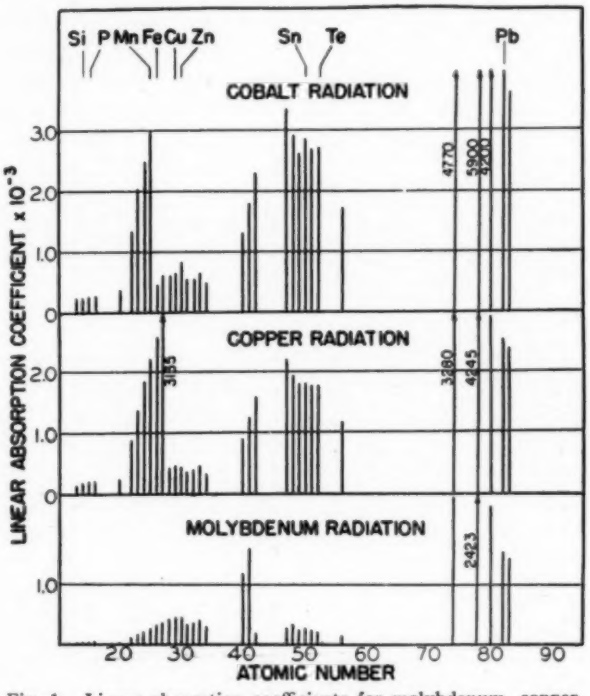

Fig. 1. Linear absorption coefficients for molybdenum, copper, and cobalt monochromatic radiation.

Radiographs using both types of radiation were made with Agfa Non-screen film and Eastman Type A film. The latter has a fine-grained emulsion and is designed for use in radiography when higher contrast is desired. Agfa Non-screen is a film with a coarser-grain emulsion and its use makes possible a reduction in exposure time. Milliamperage and exposure time were governed to make the density of the first step on the radiographic image the same in all cases. The two radiographs on each type of film were developed simultaneously. The film was placed in contact with the step wedge in every case. Experimental conditions are given in Table III. Typical step radiographs have been published by Clark and Eyler (1).

TABLE III

Pattern Number	Target Element	Kilovoltage	Milliampere-Seconds	Focal Spot-Film Distance (in.)
1	W	40	11	30
2	W	40	51	30
3	Mo	40	2	30
4	Mo	40	9	30

Densities of the images of the steps on the radiographs were measured with a Leeds and Northrup recording microphotometer. These densities are plotted against the number of the step corresponding to a given

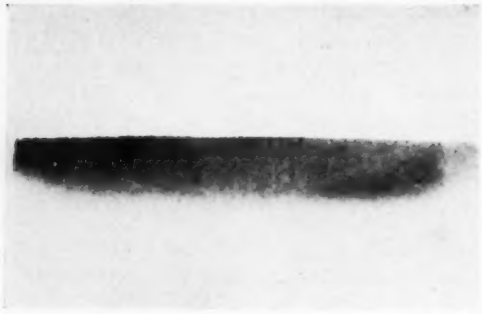

Fig. 2. Radiograph of aluminum alloy casting made with monochromatic molybdenum rays, showing hair-line cracks (cold shuts).

density. The step number is 100 times the thickness of the step in inches. It is easily apparent that there is a markedly greater change in density per step for the molybdenum characteristic ray than for the tungsten polychromatic beam.

Definition may be illustrated with a wartime experience. The following work on development of a radiographic technic was undertaken at the request of the authorities at Wright Field, Dayton, Ohio.

In the production of an aluminum alloy aircraft motor casting, the casting process leads to frequent occurrence of so-called "cold shuts," caused by failure of two advancing fronts of molten metal to fuse upon meeting. These defects occur near the upper front flange and above the ports of the casting. The metal of the top deck of the casting, in which the flaws occur, is approximately 5/16 in. in thickness and the shuts, which have the appearance of very fine regular cracks, may extend completely or only partially through the metal. Very shallow shuts are important, since they might lead to a crack extending through the entire section under the influence of vibration. Since the area involved encloses the cooling system, loss of cooling fluid and subsequent failure of the motor may follow. The defects are a few thousandths of an inch wide and may be up to an inch in length.

The previous method of inspecting these castings involved a leakage test and breaking-up of castings. In the leakage test, the casting is immersed in water and compressed air is forced into the cooling system. This test will detect any defects extending completely through the wall. Shallow defects, however, which might open under the influence of vibrational stress are not detected. The breaking test involves selecting a number of castings at random. A specified fraction of these are sawed and broken apart and the suspected regions are inspected visually. This test, however, is wasteful and leaves much to be desired in the certainty of the results. The attempt to develop a radiographic method arises from the desire to use a more certain method which is non-destructive, and one which will detect more shallow defects than are found by the leakage test.

The fact that the castings are constructed of a metal of low density and the fact that shallow defects may assume considerable importance suggested the necessity of using a low tube voltage in order to obtain the highest possible contrast. The ordinary commercial radiographic x-ray tube with tungsten target is oil-immersed for cooling, thus making possible continuous operation. In addition, the port for emission of the x-rays is made of glass. These two features lead to considerable inherent filtration in the x-ray tube itself, involving a filtering out of the longer wave lengths useful in obtaining higher contrast. Consequently, the possibility of using a diffraction type of tube with beryllium windows and water-cooled target was investigated.

Two possible advantages in the use of a molybdenum diffraction tube presented themselves. In the first place, the inherent filtration in the tube should be considerably less than in the case of an oil-immersed tube. In the second place, convenient tube voltages of 30 to 40 kv. could be used without sacrifice of contrast because of the greater intensity of characteristic radiation as compared with the general radiation, and because the wave length of the characteristic radiation does not change with increase in voltage. In effect, then, this technic involves pro-

duction of radiographs with very nearly monochromatic radiation, radiographically speaking, with a wave length of 0.71 A.U. The use of a tube with a tungsten target and operated at 30 to 40 kv. is hindered by the inherent filtration of the tube, previously discussed.

Without discussing the details of arrangement, it may be asserted that the use of monochromatic molybdenum radiation alone made the inspection possible; for tungsten polychromatic radiation did not provide sufficient contrast or definition to detect any of the cold shuts in 24 castings investigated. These fine hair-like cracks are easily seen in the molybdenum radiograph reproduced in Figure 2.

Speed is also an important consideration in radiography, especially where motion is involved. New quantitative measurements comparing a Machlett molybdenum tube with beryllium-foil windows and a standard oil-immersed tungsten radiographic tube follow. The former was operated in a Hayes diffraction unit capable of operating up to 50 kv.; the latter in a Picker 150 kv. mobile radiographic unit. The final tests were made at a distance of 10 ft.; the tungsten target tube at 50 kv. and 5 ma. delivered 4.4 r in 20 minutes; the maximum in the general radiation curve at this voltage is at 0.46 A.U. The molybdenum target tube at 50 kv., 5 ma., 10 ft. distance, delivered 11.5 r in 20 minutes; or 4.4 r in 7 minutes, 42 seconds, which was cut down to 3.5 r when a zirconium filter was used to isolate the Kα doublet at 0.71 A.U. This 2.6-fold greater dosage in a given time at this relatively great distance was most surprising, but has been borne out repeatedly in all experiments.

Next, a series of highly quantitative experiments have been run under many conditions to calibrate intensifying screens of two types when used with the two types of radiation. It is interesting to note that, in spite of this comparatively soft radiation, the films have been enclosed in regular aluminum cassettes and intensifying screens used both front and rear with remarkable success. From a mass of data used to calibrate exposures and screen speeds a few may be selected here for comparative purposes (distance 10 feet), as shown in Table IV.

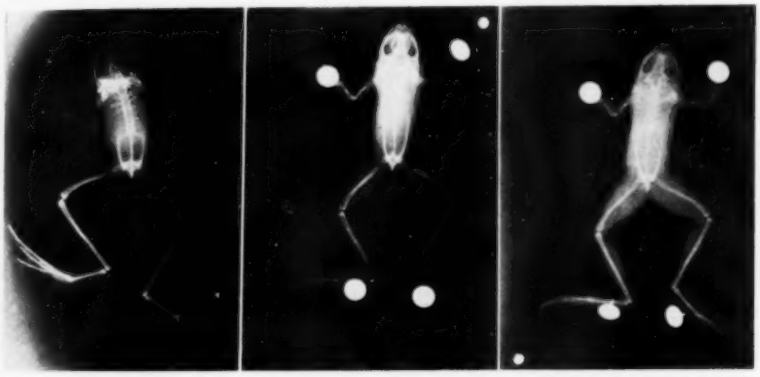

Fig. 3. Radiographs of small frog made with monochromatic radiation and polychromatic radiation. From left to right: chromium monochromatic; molybdenum monochromatic; tungsten general radiation; all at 36 kv.

This table demonstrates not only the relative speeds, but also the necessity of calibration of radiation with screen types at different excitation potentials, a matter which evidently is frequently neglected in diagnostic procedures. Under the same conditions of distance, voltage, and exposure, the monochromatic molybdenum rays are of the order of 2 1/2 times as fast with fluorazure screens as the tungsten

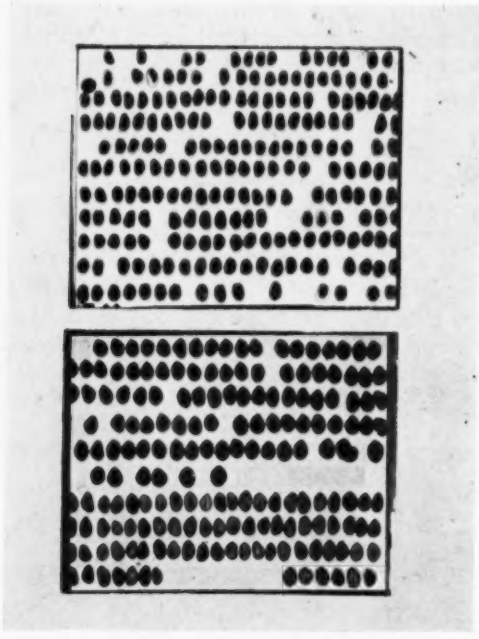

Fig. 4. Radiographs of pine seeds with polychromatic general radiation, tungsten (above), and monochromatic molybdenum radiation (below).

general radiation for the particular tubes used. It must be remembered that the molybdenum-target tube has beryllium-foil windows as commercially produced, while the tungsten-target tube is of the standard 150-kv. diagnostic type. However, a few experiments have been run with a tungsten target tube fitted with beryllium windows, of the type described by T. H. Rogers (2). Under conditions of these comparisons there is relatively little effect of the windows.

Although speed factors are decidedly favorable from the molybdenum tube, another advantage would outweigh these, even if they were distinctly unfavorable, namely, definition.

A typical industrial application requiring the extreme in radiographic definition, namely, the detection of cold shuts in aluminum alloy airplane motor castings, has already been cited. It seemed appropriate to illustrate some of the problems of biology and medical diagnosis with molybdenum monochromatic *vs.* tungsten polychromatic radiation. Examples were a small frog, a hand, and a skull. Radiographic technic may be illustrated for the skull. Assuming a common procedure of 68 kv., 12.5 ma.-seconds, 36 in. distance, and parspeed screens, and accepting a principle of doubling exposure in ma.-seconds for a drop of 14 kv., the molybdenum monochromatic radiation is generated at 48 kv. for 50 ma.-seconds with

TABLE IV

Target	Screen	Voltage (kv.)	Milli-ampere-seconds	Light Meter Reading Relative Transmission
Tungsten	Parspeed	40	10	58
	Fluorazure	40	10	25
	Parspeed	50	10	27
	Fluorazure	50	10	9.5
Molybdenum	Parspeed	40	10	43
	Fluorazure	40	4	36
	Parspeed	50	10	20
	Fluorazure	50	4	16
Tungsten	Parspeed	70	10	10
	Fluorazure	70	10	3
	Parspeed	80	10	5
	Fluorazure	80	10	2
	Parspeed	90	10	3.5
	Fluorazure	90	10	2

parscreens, and 20 ma.-seconds with fluorazure screens; and with tungsten radiation and fluorazure screens for 50 ma.-seconds. At this low potential there is not so good penetration through the skull proper as at higher values, but the detail in the softer structures, sinuses, pituitary, etc., is all that could be desired. Sharpness of detail is best indicated by enlargement of particular areas, or projection on a screen. The advantage is all with the molybdenum radiation. Trabeculation and canaliculi are clearly disclosed without enlargement with this monochromatic beam, but these extremely fine details of structure are not resolved in the tungsten radiographs. Figure 3 shows a comparison of radiographs at 36 kv., of a small frog, made with monochromatic chromium (2.286 A.U.), monochromatic molybdenum (0.71 A.U.), and generalr adiation from a tungsten target.

Fig. 5. Radiographs of hand made with monochromatic radiation, arranged in order of increasing wave length, left to right: molybdenum; copper; cobalt; chromium.

These examples, achieved by amateurs in diagnostic radiography, are meant merely to suggest possibilities; for the most incipient pathological conditions might well be detected under the extraordinary resolution of beams of essentially one wave length. Molybdenum target tubes are commercially available, and easily operated up to 50,000 volts and 20 ma. continuously. Manufacturers might easily modify the construction to reach 70,000 volts safely, with consequent increase in intensity of Kα rays, but also generation of more intense and harder general radiations, which must be filtered out with zirconium. Figure 4 illustrates the far greater sharpness of details of pine seeds radiographed with monochromatic molybdenum rays than that obtained with tungsten general radiation (standard diagnostic tube) at the same voltage.

By way of comparison, filtered monochromatic rays (actually "dichromatic" or the Kα doublet) of molybdenum, copper, cobalt, and chromium, derived from diffraction tubes at 40,000 volts, have been used for radiographs of the hand (Fig. 5). As the wave length becomes longer in the order of targets as given, the soft tissues, tendons, nails, etc., appear more and more clearly in sharp detail. Is there not a place, particularly in the larger research institutions, for a multiple selective monochromatic radiography? With proper choice of wave length adapted to a particular tissue or problem, perhaps two, three, four, or five exposures may be made, each bringing out its own constituents, or details of fine structure. For this is the technic which has made microradiography possible; the parent science of radiography (1 : 1 in the sense of relation of size of specimen to image) may easily profit by this experience.

MICRORADIOGRAPHY

Attempts to produce enlarged radiographs of small heterogeneous specimens date back to 1913, and the names of Goby, Dauvillier, and Lamarque appear in several publications on biological materials especially. It was recognized that an enlarged radiographic image could be obtained in two ways: (1) increasing the distance from specimen to plate and (2) photographic enlargement of an image registered on fine grain emulsion. By consideration of absorption indices these authors also limited their efforts to very low voltage of the order of 4,000 to 8,000, at which potentials, of course, only soft general radiation was generated. These efforts were not generally successful as medical and biological technics. Increasing distance from specimen to plate to gain enlargement only served to de-

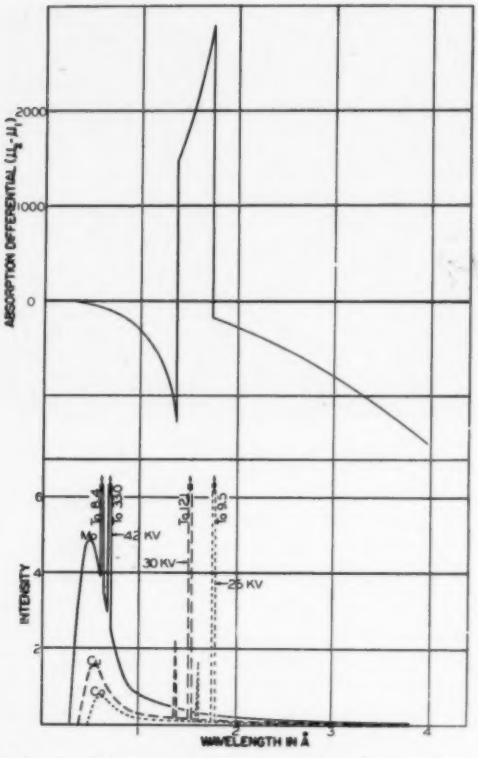

Fig. 6. Diagram illustrating choice of monochromatic radiation in microradiography for maximum differentiation (after Maddigan).

crease sharpness and definition, even though smaller and smaller focal spots were tried. Suitable tubes for such soft radiation were not generally available, and at best photographs had to be made in vacuum. Nor were suitable fine-grained photographic emulsions available to enable magnifications to a useful range of 100 diameters or above. Some improvements were made in France and Russia; but in 1938 microradiography was still in a largely unsatisfactory and unused state. In that year the author obtained in Belgium some Gevaert Lippmann emulsion, in which the silver halide grains are of the order of 1/10,000 as large as in ordinary roentgen film. With this, experiments were made with monochromatic radiation from molybdenum, copper, cobalt, iron, and chromium targets, generated at 20,000 to 30,000 volts in commercially available diffraction equipment, thus eliminating necessity for vacuum technics. Granting that the differential between linear absorption coefficients for two constituents is less favorable even for the chromium Kα radiation than for a single ray generated at 4,000 volts, yet the advantages in ease, speed, contrast detail, and sharpness of the monochromatic ray *far outweighed* the greater differential absorption of the *polychromatic* beam at 4,000 volts. The result has been a successful development beyond all expectations.

The first successful application was to complex alloy systems in which detection of phases as well as submicroscopic cracks, flaws, porosity, etc., presented a major problem. In this connection arose the use of multiple radiations for bringing out, one step at a time, complex structures of five or more components. Taking the simple case of two components (Fig. 6) the $\mu_1 - \mu_2$ values are plotted as a function of wave length from known tabulated data (for example, a copper-aluminum alloy). At some wave length will appear a peak representing maximum difference between μ_1 for copper and μ_2 for aluminum; at another wave length the curve may cross a zero axis and at still another a large negative value when $\mu_2 > \mu_1$. Obviously a monochromatic ray can be chosen, usually the Kα ray, which will fit into these peaks and thus produce the maximum differentiation in blackening, and in detail on the plate. For a second pair of components another wave length is the optimum selection. One phase may appear black with one radiation and white with another, along with all gradations of grays. This multiple selective technic solved problems of great complexity and of utmost wartime importance. Figure 7 illustrates typical microradiography of a copper-beryllium alloy which had extensive use during the war. Figure 8 shows incipient crystallization of two salts.

With biological tissues there are usually involved varying densities or thicknesses of very similar materials composed of

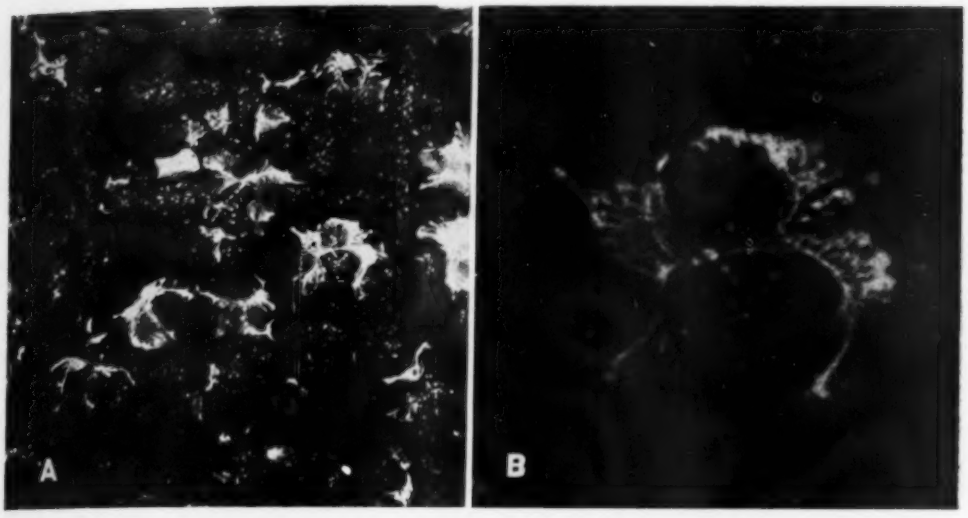

Fig. 7. Microradiography of copper beryllium alloy showing phase structure. A. × *c.* 75. B. Enclosed area from A, × *c.* 300.

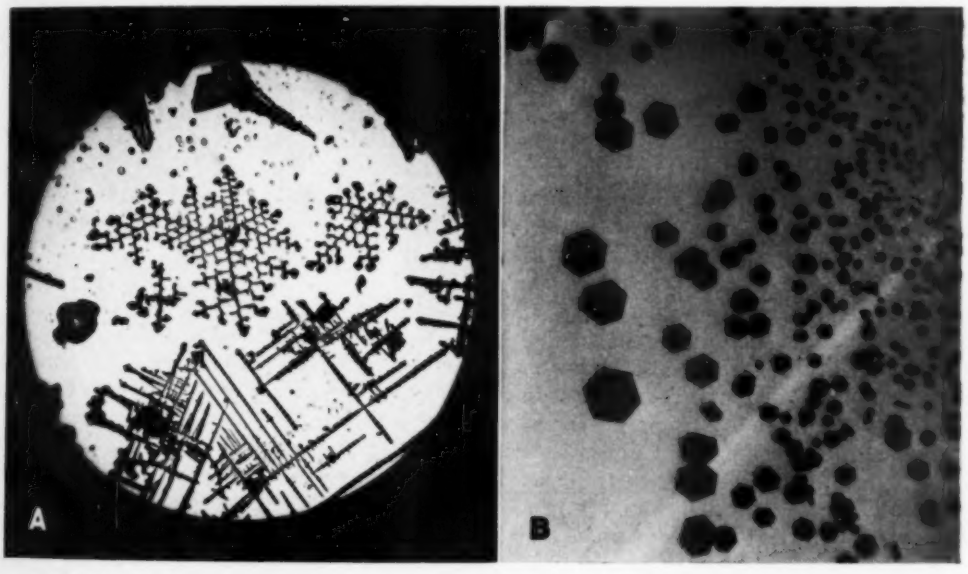

Fig. 8. Typical microradiographs of incipient crystallization. A. Silver chromate. B. Cesium bismuth iodide. × *c.* 100.

carbon, hydrogen, oxygen, nitrogen, etc., rather than phases of markedly differing absorbing power. But here again the far greater sensitivity of the monochromatic ray in contrast and definition make it possible to delineate the finer structure of tissues. Then there is always available the "staining" technic with differentially absorbing materials such as thorotrast, lead and mercury salts, iodized oils, gases, and other agents already familiar in macroradiography. Illustrated in Figures 9, 10,

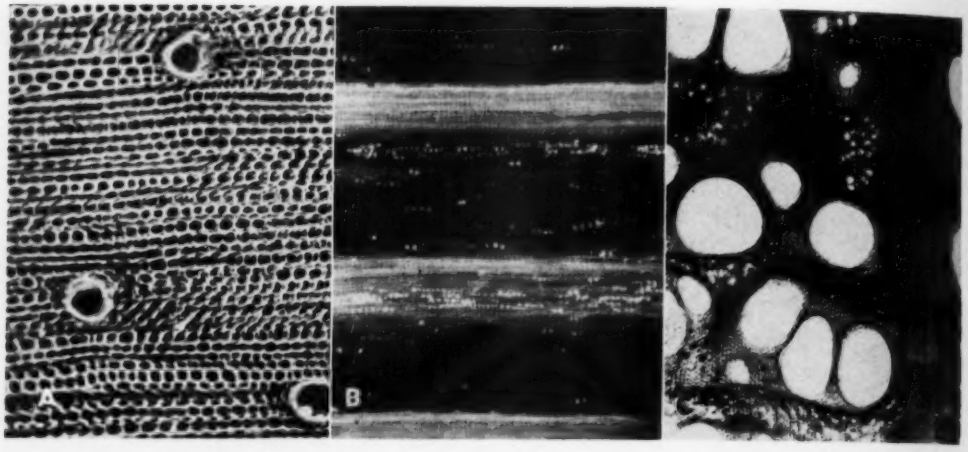

Fig. 9. Microradiographs with monochromatic radiation of oakwood sections. A. Tangential. B. Radial. C. Transverse. × *c.* 100.

and 11 are several examples of biological materials with and without impregnation.

The technic is remarkably simple. A sample sliced with a microtome is placed in close contact with the Lippmann film or the 548-0 Eastman emulsion, which is satisfactory and much faster. Thickness depends on resolution desired in this three-dimensional registration, varying from a few microns up to 100 microns or more. Exposures to the monochromatic beam are of the order of one to six minutes. A small cassette covered with black paper or opaque plastic may be used, or a small camera attached directly to the head of the diffraction tube without an intervening layer of light-protective material, inasmuch as the filter for rendering the beam monochromatic shuts out light, as does the beryllium-foil window of the tube itself. The image is developed and then enlarged with the microscope up as high as 400×.

Medical and biological microradiography by simple routine procedures is still new. In the hands of histologists and diagnosticians its possibilities are limitless, supplementing and augmenting the microscope. Its practical success has arisen from use of monochromatic beams, generated by commonly available equipment. The microradiograph at 400 : 1 has caused this re-examination of classical macroradiography at 1 : 1. Is it rash to predict that the molybdenum target tube, and indeed copper, cobalt, iron, chromium and others, may take its place along with the usual tungsten target diagnostic tube in progressive and research-minded radiological laboratories? And certainly there is yet much to be done in therapy and investigation of biological and chemical effects with these selected beams of essentially a single wave length.

SUMMARY

1. The use of essentially monochromatic roentgen rays, especially the Kα doublet from a molybdenum target with a wave length of 0.71 A.U. is demonstrated for diagnostic radiography in certain cases in comparison with tungsten radiation generated at the same voltage and current.

2. Dosage from commercially available diffraction tubes with molybdenum target is markedly greater at 10 feet than that from the usual diagnostic tubes.

3. The necessity of calibrating the speed of intensifying screens is experimentally shown.

4. Appreciably greater definition in fine detail is produced in monochromatic radiographs. Examples illustrated are extremely fine hair-line cracks in castings,

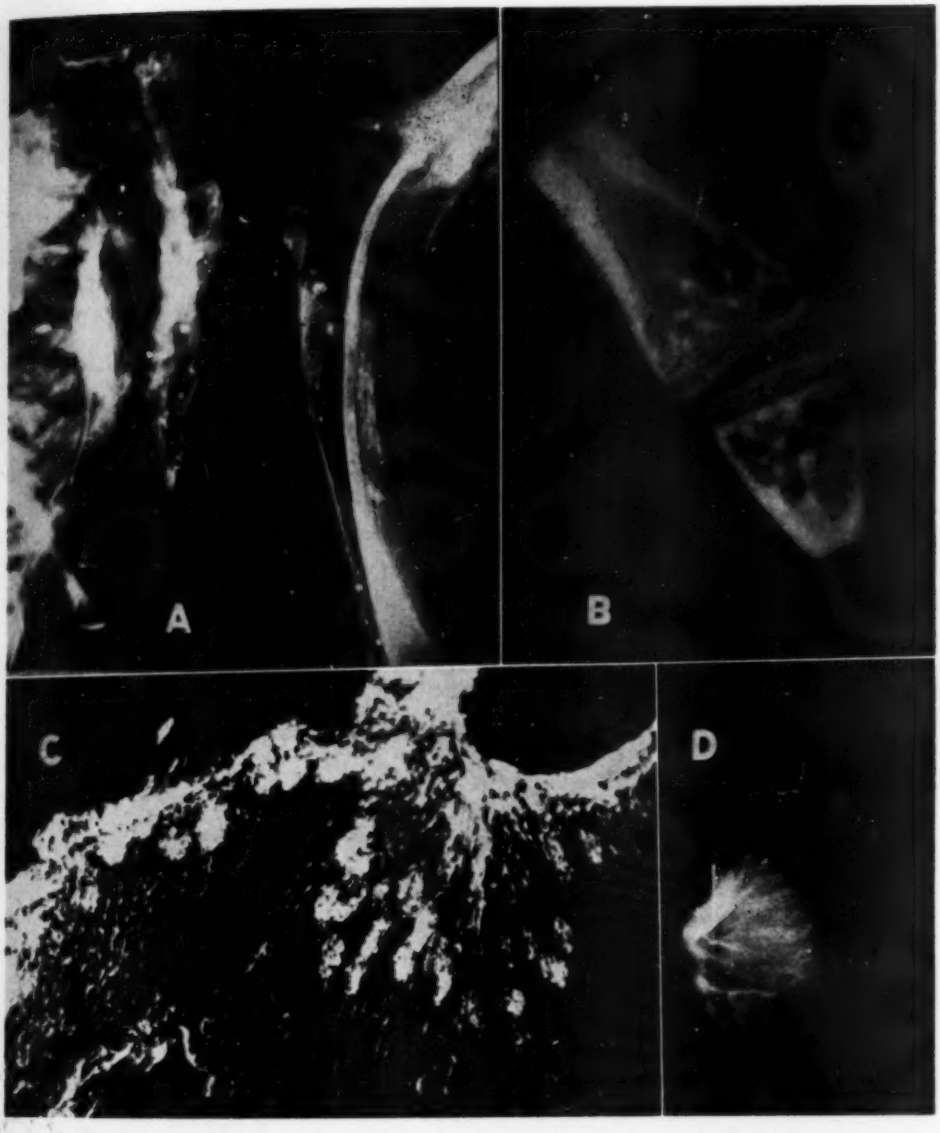

Fig. 10. Monochromatic microradiographs. ×150. A. Body of small sweat bee (spots are pollen caught on microscopic hairs). B. Smallest bone in foot of very small frog. C. Thorotrast-impregnated frog kidney. D. Circulation in embryonic bean of mercuric chloride solution.

pine seeds, frogs, and the bones of the hands. For these last, monochromatic radiographs are also shown for copper, cobalt, and chromium characteristic radiations.

5. These new tests of monochromatic macroradiography are the result of experience with microradiography, in which images registered on fine-grained photographic emulsion are enlarged up to 400 diameters, and for which monochromatic beams are essential.

6. Multiple monochromatic microradiography is the result of choice of several

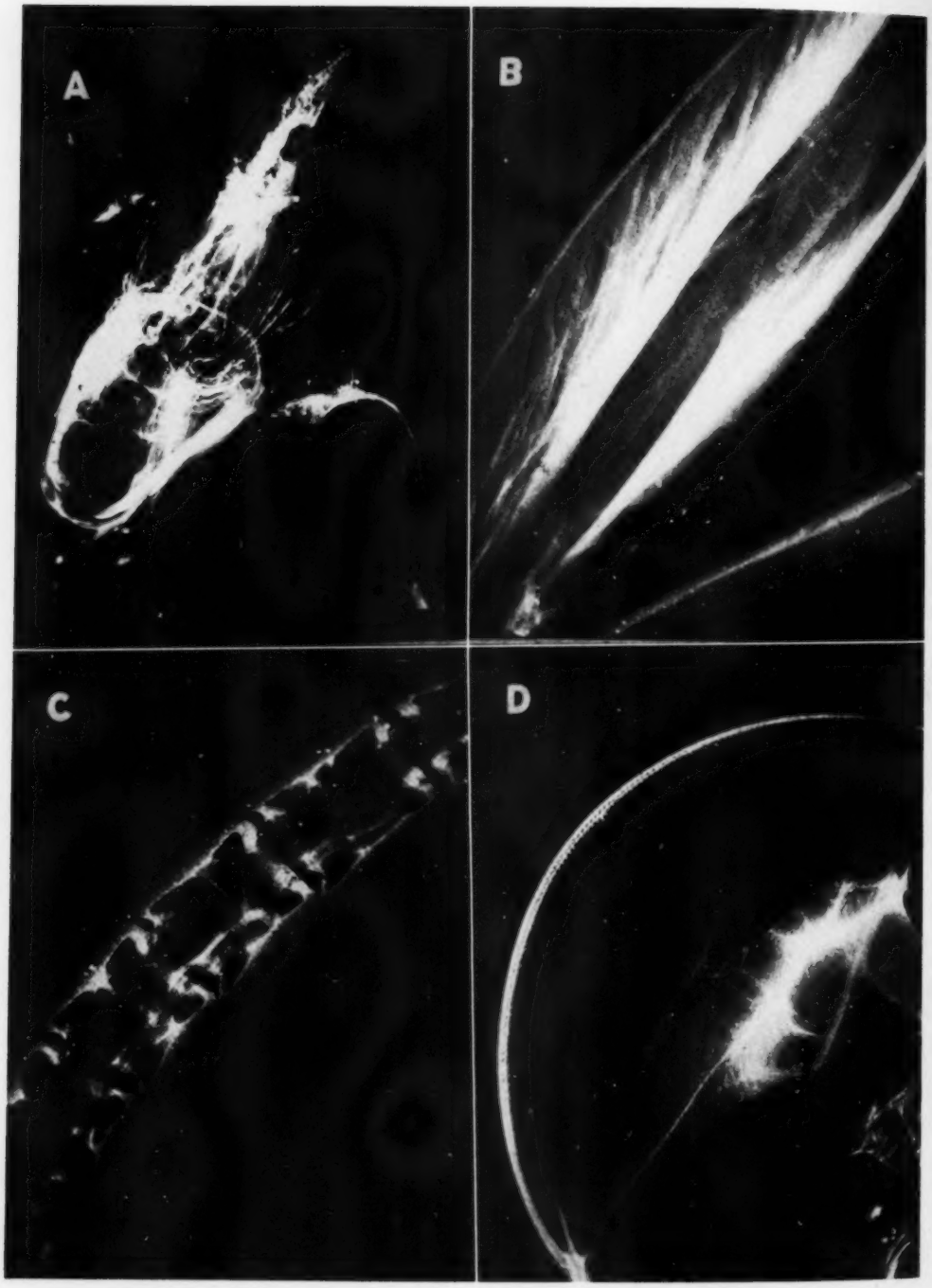

Fig. 11. Monochromatic microradiographs of parts of common housefly. ×150. A. Mouth. B. Wing. C. Antenna. D. Eye.

monochromatic rays from tubes with various targets.

7. Microradiographs of several specimens of biological or medical interest are used to illustrate the three-dimensional details of structure.

8. A plea is made for use of monochromatic radiation for special diagnostic problems and for research in roentgen-ray departments of hospitals and other institutions.

ACKNOWLEDGMENT: For indispensable assistance in formulation of ideas and technics, and for experimental tests which are still in progress, the writer acknowledges his great indebtedness to Mr. A. W. Zimmerman, Fort Wayne, Ind., and W. F. Wagner, research assistant at the University of Illinois.

Department of Chemistry
University of Illinois
Urbana, Ill.

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1. CLARK, G. L., AND EYLER, R. W.: Industrial Radiography **3:** No. 1, 13, 1944.
2. ROGERS, T. H.: Radiology **48:** 594, 1947.

SUMARIO

Aplicaciones Médicas, Biológicas e Industriales de la Radiografía Monocromática y la Microrradiografía

1. Muéstrase el empleo, para el diagnóstico radiográfico en ciertos casos, de rayos X esencialmente monocromáticos, y especialmente de los dobles Kα de un foco de molibdeno con un largo de onda de 0.71 U. A., comparándolos con la radiación de tungsteno generada a los mismos voltaje y corriente.

2. A una distancia de 3 m., la dosis de los tubos de difracción obtenible en el comercio es mucho mayor que la de los tubos corrientes de diagnóstico.

3. Demuéstrase experimentalmente la necesidad de calibrar la velocidad de las pantallas intensificadoras.

4. En las radiografías monocromáticas obtiénese una definición apreciablemente mayor de los detalles delicados. Como ejemplos preséntanse finísimas grietas en impresiones, semillas, ranas y huesos de las manos. Para los últimos también se presentan radiografías monocromáticas con típicas radiaciones de cobre, cobalto y cromo.

5. Estos nuevos ensayos de la macrorradiografía monocromática son consecuencia de las observaciones realizadas con la microrradiografía, en la cual se agrandan hasta 40 diámetros las imágenes registradas en emulsiones de granos finos, siendo indispensable para ella los rayos monocromáticos.

6. La microrradiografía monocromática múltiple representa el resultado de la elección de varios rayos monocromáticos procedentes de tubos con varios focos.

7. A fin de demostrar los pormenores en tres dimensiones de su composición, utilízanse microrradiografías de varios ejemplares de interés biológica o médicamente.

8. Abógase por el empleo de la radiación monocromática en ciertos problemas especiales de diagnóstico y para fines de investigación en los departamentos de roentgenología de los hospitales y otras instituciones.

EDITORIAL

To the Members of the Radiological Society of North America

Historic Boston extends a most cordial welcome to the members, their families, and guests on the occasion of the Thirty-third Annual Meeting of the Radiological Society of North America at the Hotel Statler, Boston, November 30 to December 5, 1947.

The scientific program and exhibits promise to fulfill the best traditions of the Society. The fruitful "refresher courses," original with this Society, remain as an integral part of the program. The commercial exhibits will be varied and embrace all the recent and projected developments in diagnostic and therapy apparatus.

An interesting Ladies' Program has been planned, comprising a tour of Boston including the Gardner Museum and a visit to Harvard College in Cambridge to see the world renowned collection of glass flowers.

Many of the historic places are within walking distance of the Society's hotel headquarters. Nearby is the State House showing the Bulfinch front, designed by Charles Bulfinch, considered one of the great architects of Colonial times. The dome of the State House, gilded in gold leaf, was painted gray during World War II, but has now been restored.

The Paul Revere House, 19 North Square, is the oldest house in the City of Boston. Built about 1660, it was purchased by Paul Revere in 1770 and there he resided until 1800. The immense fireplaces and ancient wall paper, and many other features of the Colonial period, make it a most interesting house to visit. It was restored in 1908.

The Old North Church, built in 1723, remains a classic in its lines. It was from the steeple of this church that the signal lanterns of Paul Revere were displayed on April 18, 1775, which warned the country of the march of the British troops to Lexington and Concord.

Bunker Hill Monument occupies the spot on which one corner of the American redoubt at the Battle of Bunker Hill was located. The monument was begun in 1825 but remained unfinished until 1840, when its construction was recommenced largely through the efforts of American women. It is constructed of granite brought from the Quincy granite quarries by America's first steam railway.

Boston has not alone been first in things politic, but has pioneered in liberal education and medicine. Harvard College and the Massachusetts Institute of Technology are just across the Charles River. The Boston College group of buildings, at Chestnut Hill, is considered one of the finest examples of Gothic architecture in America.

Harvard Medical School and its classic marble lecture halls and laboratories are in Boston proper, surrounded by the Boston Lying-In Hospital, the Children's Hospital, and the Peter Bent Brigham Hospital. It was while a student at Harvard Medical School, in 1898, that Dr. Walter Cannon made his classical observations on the movements of the stomach, using an opaque medium.

The New England Medical Center, the teaching unit of Tufts Medical College, is in down-town Boston and comprises the Boston Dispensary, the Floating Hospital for Children, the Pratt Diagnostic Center, and a new surgical building and medical school.

Boston University Medical School is in the South End of Boston with its own modern medical and surgical wings and the Evans Memorial Research laboratory.

The Boston City Hospital of 2,500 beds is close by and is used by all medical schools for teaching. Here is the Thorndike Memorial Laboratory for research, with Drs. George Minot and William Castle directing. It was at the Boston City Hospital in 1896, only a year after Roentgen's discovery, that Dr. Francis Williams began his unforgettable work in roentgen diagnosis, using a fluoroscope energized by a static machine which he had himself made.

The Massachusetts General Hospital remains unique. Perhaps best known for the demonstration of Morton's discovery of ether, it has remained in the forefront of the great teaching hospitals of the world. Walter Dodd, the hospital pharmacist, later to receive his medical degree from the University of Vermont and die a martyr to the cause, was first to interest himself in Roentgen's newly discovered rays. He was succeeded by Dr. George W. Holmes, to whom so many students and radiologists in general owe so much.

All of these institutions are near by and will receive gladly any member of the R.S.N.A. Anyone interested in any particular surgical operation will find all operations for the day posted at the Medical Library, 8 Fenway, which by the way houses many unusual incunabula.

Hotel accommodations will be adequate but reservations should be made early.

FREDERICK W. O'BRIEN, M.D.,
President

THE PAUL REVERE HOUSE

The Paul Revere House, 19 North Square, is the oldest house in the City of Boston. It was built about 1660 and was purchased by Paul Revere in 1770. It was restored in 1908 and is open to the public on weekdays and holidays from 10 A.M. to 4 P.M.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

THIRTY-THIRD ANNUAL MEETING, HOTEL STATLER, BOSTON
NOV. 30–DEC. 5, 1947

Sunday, November 30

PRELIMINARY PROGRAM

REGISTRATION

QUIZ PROGRAM

7:00 P.M.

Contestants: JOHN D. CAMP, M.D., L. HENRY GARLAND, M.D., FRED J. HODGES, M.D., and LEO G. RIGLER, M.D.
Referee: MERRILL C. SOSMAN, M.D.

Monday, December 1

GENERAL SESSION: 10:30 A.M.

CALL TO ORDER

FREDERICK W. O'BRIEN, M.D., President
Boston, Mass.

ADDRESS OF WELCOME

EDWARD F. BAGG, M.D.

President of Massachusetts Medical Society

PRESIDENTIAL ADDRESS

RADIOLOGY AND THE PRACTICE OF MEDICINE

FREDERICK W. O'BRIEN, M.D.

THE ECONOMICS OF MEDICINE
(A SYMPOSIUM)

Chairman: Lowell S. Goin, M.D.

REV. ALPHONSE SCHWITALLA, S.J.
DR. MARJORIE SHEARON
MR. MAC F. CAHAL, Executive Secretary, American College of Radiology

COUNSELLORS' LUNCHEON: 12:15 P.M.

DIAGNOSTIC SESSION: 2:00 P.M.

1. An Analysis of X-ray Findings in 405 Cases of Benign Gastric and Pyloric Ulcers, WALTER A. RUSSELL, M.D., SIDNEY WEINTRAUB, M.D., and HAROLD L. TEMPLE, M.D., New York Hospital, New York, N. Y.
2. Roentgenological Deformities of the Pyloric Portion of the Stomach with Absence of Surgical and Pathological Findings, EDWARD L. JENKINSON, M.D., Chicago, Ill.
3. X-ray Observations Before and After Vagotomy, WARREN W. FUREY, M.D., Chicago, Ill.
4. Spindle-Cell Tumors of the Gastro-Intestinal Tract, WILLIAM L. PALAZZO, M.D., and MILFORD D. SCHULZ, M.D., Massachusetts General Hospital, Boston, Mass.
5. The Significance of Gas in Hepatic Ducts, WILLIAM J. ELLIOT, M.D., JAMES R. LINGLEY, M.D., and JOHN F. SHEEHAN, M.D., Worcester Mass.
6. Trichobezoar (Hair Ball), JOHN DAY PEAKE, M.D., Mobile, Ala.

THERAPY SESSION: 2:00 P.M.

1. Measurement of High Energy Neutrons, G. FAILLA, PH.D., New York, N. Y.
2. Biological Effects of High Energy Neutrons, T. C. EVANS, PH.D., New York, N. Y.
3. Protection from 1 and 2 Million Volt X-rays, C. B. BRAESTRUP, New York, N. Y.
4. Distribution of Radioactive Isotopes by the Atomic Energy Commission and Some Medical Applications, P. C. AEBERSOLD, Oak Ridge, Tenn.
5. Very High Energy Ionizing Radiations
6. Further Observations on the Use of Three Million Volt Roentgen Ray Therapy, RICHARD DRESSER, M.D., Boston, Mass.
7. Physical Basis for the High Skin Tolerance of Supervoltage Roentgen Rays, JOHN G. TRUMP, Sc.D., Massachusetts Institute of Technology, Cambridge, Mass.
8. Concrete Protective Studies at Roentgen-Ray Potentials of up to 1400 Kilovolts, HAROLD O. WYCKOFF and LAURISTON S. TAYLOR, Washington, D. C.

MEMBERSHIP DINNER AND EXECUTIVE SESSION: 7:00 P.M.

Tuesday, December 2

DIAGNOSTIC SESSION: 10:15 A.M.

1. Pulmonary Emphysema and Pulmonary Fibrosis: Clinical, Pathological and Roentgen Aspects, DONALD S. KING, M.D., TRACY B. MALLORY, M.D., and LAURENCE L. ROBBINS, M.D., Massachusetts General Hospital, Boston, Mass.
2. Miliary Calcification of the Lungs, HOWARD P. DOUB, M.D., Detroit, Mich.

3. Intratracheal Atomization in the Diagnosis and Treatment of Disease of the Respiratory Tract, PEDRO L. FARIÑAS, M.D., Havana, Cuba.
4. The Pathogenesis of Bronchiectasis: A Roentgen Contribution, FELIX G. FLEISCHNER, M.D., Boston, Mass.

THERAPY SESSION: 10:30 A.M.

1. Roentgen Therapy of Carcinoma of the Lower Lip, J. A. DEL REGATO, M.D., Columbia, Mo.
2. Importance of X-ray Examination in Cancer of the Larynx and Hypopharynx, FELIX E. LEBORGNE, Montevideo, Uruguay.
3. Cancer of the Larynx: Five Year Results of Concentration Radiotherapy, MAX CUTLER, M.D., Chicago, Ill.
4. The Selection of the Treatment Method in Larynx Cancer, HAYES E. MARTIN, M.D., New York, N. Y.
5. Roentgen Therapy of Carcinoma of the Larynx: Fifteen Years' Experience, WILLIAM HARRIS, M.D., RUDOLPH KRAMER, M.D., and SIDNEY M. SILVERSTONE, New York, N. Y.

EXECUTIVE SESSION: 1:45 P.M.

Report of Nominating Committee

DIAGNOSTIC SESSION: 2:30 P.M.

1. Some Considerations of the Roentgen Diagnosis of Silicosis and Conditions that May Simulate It, EUGENE P. PENDERGRASS, M.D., and AGRIPPA G. ROBERT, M.D., University of Pennsylvania, Philadelphia, Penna.
2. Significance of Occupational History in the Diagnosis of Silicosis, THEODORE HATCH, Industrial Hygiene Foundation, Pittsburgh, Penna.
3. Anthraco-Silicosis, WILLIAM J. CORCORAN, M.D. Scranton, Penna.
4. Pathogenesis of Industrial Pulmonary Disease, WILLARD F. MACHLE, M.D., New York, N. Y.
5. Further Observations of Lung Changes Associated with the Manufacture of Alumina Abrasives, C. G. SHAVER, M.D., St. Catherines, Ontario, Canada.
6. Delayed Pneumonitis of Unknown Origin Occurring in Workers with Fluorescent Powders, STANLEY A. WILSON, M.D., Salem, Mass.

THERAPY SESSION: 2:30 P.M.

1. Induction of Leukemia in Inbred Mice by X-rays, HARRY W. MIXER, M.D., and ARTHUR KIRSCHBAUM, M.D., University of Minnesota Medical School, Minneapolis, Minn.
2. The Practical Aspects of the Diagnosis, Treatment and Prognosis of Hodgkin's Disease and Allied Disorders, HENRY JACKSON, JR., M.D., Boston, Mass.
3. Pathologic Aspects of Lymphoid Tumors, SHIELDS WARREN, M.D., Boston, Mass.
4. Clinical Uses of Nitrogen Mustards, LLOYD F. CRAVER M.D., Memorial Hospital New York.
5. The Newer Nitrogen Mustards in the Treatment of Leukemia, JOSEPH H. BURCHENAL, M.D., The Sloan-Kettering Institute for Cancer Research, New York, N. Y.
6. Pathological Changes Following the Use of Nitrogen Mustards, SOPHIE SPITZ, M.D., New York.
7. Orbital Lymphomas, MILFORD D. SCHULZ, M.D., and PARKER HEATH, M.D., Massachusetts General Hospital, Boston, Mass.
8. Radiation Treatment of Lymphoid Tumors, HUGH F. HARE, M.D., C. F. SORNBERGER, M.D., and W. C. MULRY, M.D., Lahey Clinic, Boston, Mass.

THE CARMAN LECTURE: 8:00 P.M.

DOUGLAS QUICK, M.D.
New York, N. Y.

Wednesday, December 3

DIAGNOSTIC SESSION: 10:15 A.M.

SYMPOSIUM ON PEDIATRIC ROENTGENOLOGY

RALPH S. BROMER, M.D., Philadelphia Children's Hospital; JOHN CAFFEY, M.D., Babies Hospital, New York; DONALD L. MCRAE, M.D., Montreal Children's Hospital; WILLIAM A. EVANS, JR., M.D., Detroit Children's Hospital and MARTIN H. WITTENBORG, M.D., Children's Hospital, Boston, Mass.

THERAPY SESSION: 10:15 A.M.

SYMPOSIUM ON RADIOACTIVE IODINE

1. Radioactive Iodine as a Tool in the Study of Thyroid Physiology, RULON W. RAWSON, M.D., Massachusetts General Hospital, Boston, Mass.
2. Radioactive Iodine Studies of Functional Thyroid Carcinoma, VIRGINIA KNEELAND FRANTZ, M.D., New York, N. Y.
3. Factors Involved in the Experimental Therapy of Metastatic Thyroid Cancer with I^{131}, A. F. HOCKER, M.D., and J. B. TRENNELL, M.D., New York.
4. Treatment of Hyperthyroidism with Radioactive Iodine (8-day half life), EARLE M. CHAPMAN, M.D., Massachusetts General Hospital, Boston, Mass.
5. Clinical Experience in Diagnosis and Treatment of Toxic Goiter with Radioactive Iodine (8-day half life) SIDNEY C. WERNER, M.D., and EDITH H. QUIMBY, Sc.D., Columbia University, New York.

DIAGNOSTIC SESSION: 2:00 P.M.

1. Adult and Four Chamber Angiocardiography, GEORGE P. ROBB, M.D., Washington, D. C.
2. Angiocardiography in Congenital Heart Disease, R. N. COOLEY, M.D., H. T. BAHNSON, M.D., and C. R. HANLON, M.D., Johns Hopkins Hospital, Baltimore, Md.
3. Further Experience with the Right Heart Catheter in Congenital Heart Disease, LEWIS DEXTER, M.D., Peter Bent Brigham Hospital, Boston, Mass.

4. Radiographic Demonstration of Anomalies of the Aorta and Great Vessels, E. B. D. NEUHAUSER, M.D., Children's Hospital, Boston, Mass.
5. Surgical Experience with Coarctation of the Aorta and Double Aortic Arch, ROBERT E. GROSS, M.D., Children's Hospital, Boston, Mass.
6. Cerebral Arteriography and Aneurysms of the Cerebral Arteries, JAMES L. POPPEN, M.D., Lahey Clinic, Boston, Mass.
7. Venography of the Extremities, GEORGE MIXTER, M.D., Massachusetts Memorial Hospital, Boston, Mass.
8. Scalloped Ribs Without Coarctation, PHILIP BATCHELDER, M.D., and ROBERT J. WILLIAMS, M.D., Providence, R. I.

THERAPY SESSION: 2:00 P.M.

1. Roentgen Therapy of Carcinoma of the Vulva and Female Urethra, FRANZ BUSCHKE, M.D., and SIMEON T. CANTRIL, M.D., Seattle, Wash.
2. Intracavitary Radium Therapy and the Immediate and Late Results in Cancer of the Cervix, HARRY H. BOWING, M.D., Mayo Clinic, Rochester, Minn.
3. The Treatment of Cancer of the Cervix Uteri by Intravaginal Roentgen Therapy, GRAY H. TWOMBLY, M.D., New York, N. Y.
4. Review of Ten Years' Experience with Transvaginal Roentgen Therapy, RALPH M. CAULK, M.D., Washington, D. C.
5. External Deep X-ray Therapy: An Adjunct in the Treatment of Carcinoma of the Cervix Uteri with the Long Interstitial Element Needles, GEORGE W. WATERMAN, M.D., Providence, R. I.
6. Carcinoma of the Cervical Stump, WILLIAM E. COSTOLOW, M.D., Los Angeles, Calif.
7. Carcinoma of Cervix Uteri: Improvement of Radiation Technic with Aid of Serial Biopsies and Million Volt Roentgen Therapy, MILTON FRIEDMAN, M.D., New York, N. Y.
8. Future Probable Trends in the Irradiation Treatment of Carcinoma of the Cervix with a New Type of Expanding Cervical Colpostat Radium Applicator, EDWIN C. ERNST, M.D., Barnard Free Skin and Cancer Hospital, St. Louis, Mo.

Thursday, December 4

DIAGNOSTIC SESSION: 10:15 A.M.

1. The Effect of the Variations of the Nasal Sinuses on the Roentgenograms, FRED W. DIXON, M D. Cleveland, Ohio.
2. Clinical and Roentgenological Consideration of Nasal Sinus Conditions, A. S. MACMILLAN, M.D., and LEROY A. SCHALL, M.D., Boston, Mass.
3. A Study of the Cervical Subarachnoid Space with Particular Reference to Arnold-Chiari Malformation and Syringomyelia, JOSEPH H. MARKS, M.D., and KENNETH E. LIVINGSTON, M.D., Boston, Mass.
4. Intraventricular Epidermoid, HARRY HAUSER, M.D., and CHARLES W. ELKINS, M.D., Cleveland, Ohio.
5. The Diagnosis and Treatment of Medulloblastoma, CARLETON B. PEIRCE, M.D., and WILLIAM V. CONE, M.D., Montreal, Canada.

THERAPY SESSION: 10:15 A.M.

1. The Treatment of Multiple Myeloma, L. HENRY GARLAND, M.D., San Francisco, Calif.
2. Hormonal Studies in Breast Cancer, IRA T. NATHANSON, M.D., Boston, Mass.
3. The Treatment of Breast Cancer Metastatic to Bone with Testosterone, FRANK E. ADAIR, M.D., New York, N. Y.
4. Clinical Manifestations of Pituitary Disease, LEWIS M. HURXTHAL, M.D., Boston, Mass.
5. Diagnosis and Treatment of Pineal Tumors, GILBERT HORRAX, M.D., Boston, Mass.

EXECUTIVE SESSION: 1:45 P.M.

Election of Officers

DIAGNOSTIC SESSION: 2:00 P.M.

1. Roentgen Evaluation of Hip Lesions in Infancy and Childhood; Based on Experience at Newington Home for Crippled Children, GILBERT W. HEUBLEIN, M.D., LOUIS BERNSTEIN, M.D., and B. J. HUBENET, M.D., Hartford, Conn.
2. Eosinophilic Granuloma and Xanthomatosis, WILLIAM T. GREEN, M.D., Boston, Mass.
3. Eosinophilic Granuloma and Xanthomatosis, SYDNEY FARBER, M.D., Boston, Mass.
4. The Osseous Manifestations of Neurofibromatosis: With Special Reference to Lesions of the Ribs, JOHN F. HOLT, M.D., and EDWIN M. WRIGHT, M.D., Ann Arbor, Mich.
5. Sickle-cell Anemia in Adults with Osseous and Visceral Manifestations, ROBERT P. BALL, M.D., and OMAR K. LEGANT, M.D., Presbyterian Hospital, New York, N. Y.
6. Polyostotic Fibrous Dysplasia (Albright's Syndrome) and Its Comparison with Chondroplasia (Ollier's Disease): A Correlation of the Pathological and Radiological Findings, L. R. SANTE, M.D., WILLIAM BAUER, M.D., and R. M. O'BRIEN, M.D., St. Louis, Mo.
7. Meningocele Within the Sacrum, V. W. ARCHER, M.D., GEORGE COOPER, JR., M.D., and R. R. HOFFMAN, M.D., University, Va.

THERAPY SESSION: 2:00 P.M.

1. Roentgen-ray Treatment of Bacteridia Carbonosa Infections, MANUEL RIEBELING, M.D., Guadalajara, Mexico.
2. Radiation Therapy of Thrombophlebitis, JOHN S. BOUSLOG, M.D., Denver, Colo.

3. Radiation Treatment of Hemangiomas, ROBERT B. TAFT, M.D., Charleston, S. C.
4. Roentgen-Ray Treatment of Severe Asthma, E. T. LEDDY, M.D., Mayo Clinic, Rochester, Minn.
5. Radiation Necrosis of the Jaw, ERNEST M. DALAND, M.D., Boston, Mass.
6. The Use of X-rays in the Prevention and Treatment of Infections, JAMES F. KELLY, M.D., D. A. DOWELL, M.D., and JOHN E. DOWNING, M.D., Omaha, Nebr.

ANNUAL BANQUET: 7:00 P.M.

Friday, December 5

GENERAL SESSION: 10:15 A.M.

1. The Roentgenologic Examination as an Aid in Diagnosis of Malignant and Potentially Malignant Lesions of the Large Bowel, JOSEPH C. BELL, M.D., and JAMES B. DOUGLAS, M.D., Louisville, Ky.
2. Radiological Aspect of Amebic Colitis, J. J. VALLARINO, M.D., Washington, D. C.
3. Large Lymphoid Cell Collections in the Mucosa of the Terminal Ileum: Its Effect on Barium Shadows, JOSEPHINE S. WELLS, M.D., New York, N. Y.
4. Acute Small Intestinal Obstruction, IRA LOCKWOOD, M.D., ARTHUR B. SMITH, M.D., and JOHN W. WALKER, M.D., Research Clinic, Kansas City, Mo.
5. Extrinsic Deformities of the Colon, ROBERT C. PENDERGRASS, M.D., Americus, Ga.
6. Barium Sulfate in Saline Suspension. Examination of the Left Colon in the Presence of Partial Obstruction, GEORGE M. WYATT, M.D., Washington, D. C.

GENERAL SESSION: 2:00 P.M.

1. Arthrograms, HAMPAR KELIKIAN, M.D., and ELBERT K. LEWIS, M.D., Chicago, Ill.
2. Chronic Idiopathic Hypertrophic Osteoarthropathy, JOHN D. CAMP, M.D., and ROBERT L. SCANLAN, M.D., Mayo Clinic, Rochester, Minn.
3. Contact Therapy in Treatment of Superficial Lesions, W. S. ALTMAN, M.D., Quincy, Mass., B. LEVINE, M.D., and H. F. FRIEDMAN, M.D., Boston, Mass.
4. Prenatal Estimation of Birth Weight by Pelvicephalometry, S. W. DONALDSON, M.D., and WILLIAM D. CHENEY, M.D., Ann Arbor, Mich.
5. Hydronephrosis: A Radiological Classification Based on Anatomical Variations, SAMUEL A. ROBINS, M.D., and JOSEPH FISCHMAN, M.D., Boston, Mass.
6. A Study of the Hands of Radiologists, MARGARET NICKSON, Argonne National Laboratory, Chicago, Ill.
7. Rotation Therapy, SYDNEY J. HAWLEY, M.D., Seattle, Wash..
8. Treatment of Deep-Seated Malignant Growths with Multiple Port Technic Simulating Rotation Therapy, IRA I. KAPLAN, M.D., and S. I. ETKIN, M.D., Bellevue Hospital, New York.

ANNUAL MEETING, RADIOLOGICAL SOCIETY OF NORTH AMERICA

As everyone must know by now, the Thirty-Third Annual Meeting of the Radiological Society of North America will be held in Boston, Nov. 30 to Dec. 5, with headquarters at the Hotel Statler.

The program of Refresher Courses, which will begin on Sunday, Nov. 30, was included in RADIOLOGY for September. The Scientific Program appears elsewhere in this issue.

The Women's Committee has prepared a very interesting program for the lady guests and is anxious to contact as many of the women as possible so that they will know how many are going to attend.

On Monday, Dec. 1, a breakfast at 10:00 A.M. at the Women's City Club, 39 Beacon St., followed by a book review by Alice Dickson Bond, is planned. On Tuesday there will be a concert and tour of Mrs. Jack Gardner's palace, with transportation provided, and Wednesday a tour of historic Boston lasting three and one half hours.

The ladies are requested to take notice of the special program planned for them at the Boston meeting.

AMERICAN MEDICAL ASSOCIATION SECTION ON RADIOLOGY

The American Medical Association will hold its 1948 annual session in Chicago, June 21–25. Those who wish to present papers before the Section on Radiology should communicate with the secretary, Dr. U. V. Portmann, 2020 E. 93rd St., Cleveland 6 Ohio, before Dec. 1, 1947.

AMERICAN COLLEGE OF RADIOLOGY

New officers elected at the 24th annual meeting of the American College of Radiology are: E. C. Ernst, M.D., St. Louis, President, to succeed E. H. Skinner, M.D., Kansas City; Charles L. Martin, M.D., Dallas, Vice-President; Warren Furey, M.D., Chicago, Treasurer. Lewis G. Allen, M.D., Kansas City, Kan., was elected to the Board of Chancellors, and E. P. Pendergrass, M.D., Philadelphia, was re-elected as Chairman of the Board of Chancellors.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Over 165 registered for the meeting of the Rocky Mountain Radiological Society, in Denver, Aug. 7–9. Among the guest speakers were: Dr. Lloyd Craver, Dr. Kenneth Corrigan, Dr. Eldwin Witwer, Dr. Claude Hunt, Dr. Leo Rigler, Dr. Lowell Goin, and Dr. Edgar McNamee.

The following officers were elected for the ensuing year: Dr. James P. Kirby, Salt Lake City, President; Dr. Howard B. Hunt, Omaha, Nebr., President-elect; Dr. Q. B. Coray, Salt Lake City, 1st Vice-President; Dr. E. M. Hayden, Tucson, Ariz., 2d Vice-President: Dr. John Bouslog, Denver, Colo., Historian; Dr. M. D. Frazer, Lincoln, Nebr., Secretary-Treasurer.

The next annual meeting of the Society will be held in Salt Lake City.

A NEW ITALIAN JOURNAL OF RADIOLOGY

There have recently been received in the editorial offices of RADIOLOGY issues of a new Italian journal *Radiologia*, under the editorship of Professor Eugenio Milani, Director of the Instituto di Radiologia Medica, University of Rome. Dr. Milani is interested in receiving articles for publication from American radiologists and asks that such contributions be addressed to him at Instituto di Radiologia Medica dell'Università di Roma, Policlinico Umberto I, Roma.

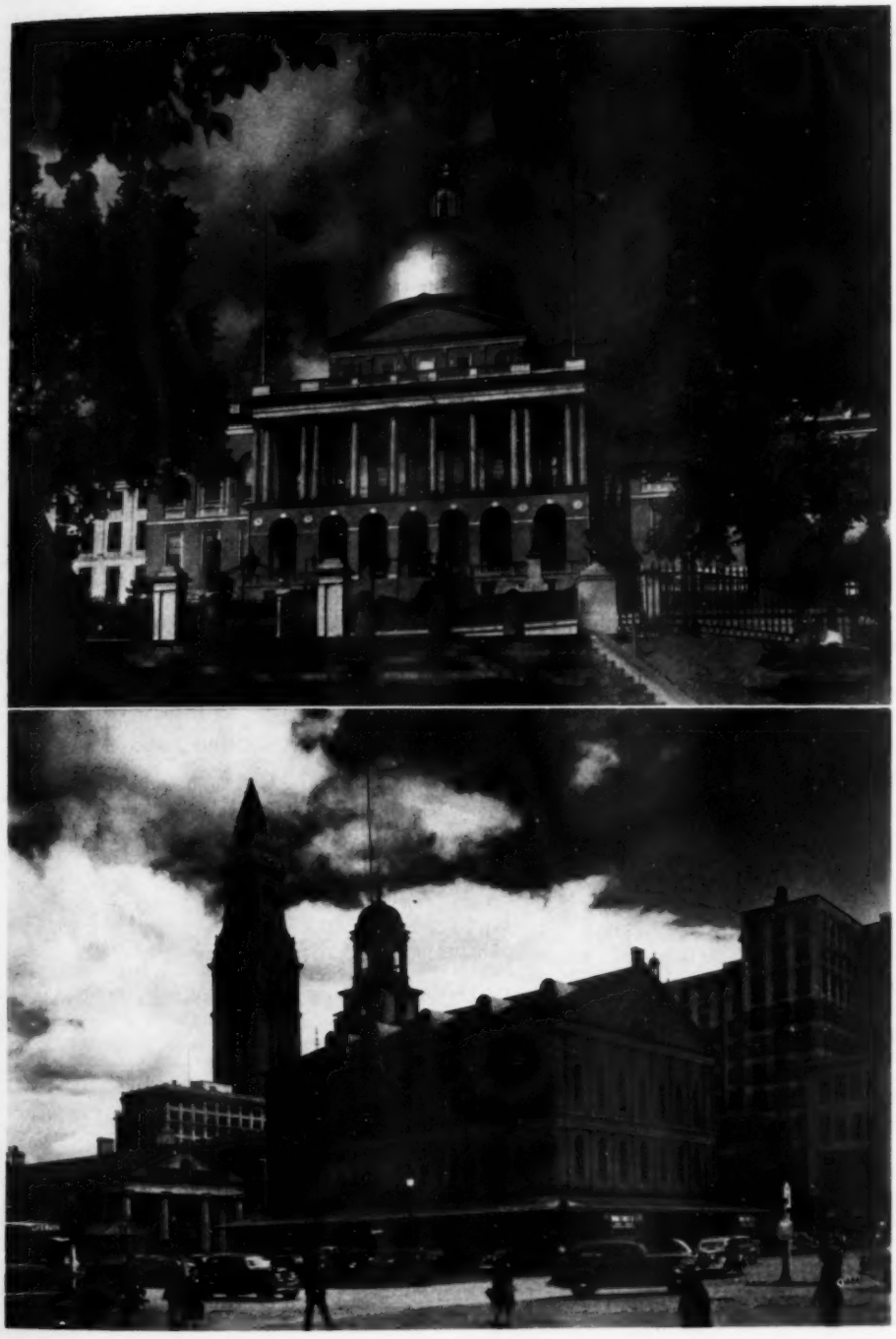
In Memoriam

HAROLD BENJAMIN THOMPSON, M.D.
1883–1947

Harold Benjamin Thompson, M.D., of Seattle, Washington, one of the early radiologists of the Pacific Northwest, succumbed to coronary thrombosis on June 16, 1947, after practi ing his specialty for thirty-five years.

Dr. Thompson was born in Appleton, Wisconsin, in 1883. He graduated from Rush Medical College in 1908. His interest in radiology appeared early in his career. While still a medical student, he worked in the incipient department of radiology at Cook County Hospital. He started general practice in Seattle in 1909, and after 1912 limited his practice to radiology. He was radiologist to the Seattle General Hospital from 1915 to 1946 and during the same period was consultant in radiology at the Children's Orthopedic Hospital.

Dr. Thompson was a Fellow of the American College of Radiology and a member of the Radiological Society of North America, the Washington State Radiological Society, and the Pacific Northwest Radiological Society. His wide experience, and keen ability at observation and diagnosis won him the respect of all his colleagues. His death marks not only the loss of a pioneer in radiology, but a wise counsellor and sincere friend to the profession of medicine.



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HISTORIC BOSTON

The State House and Faneuil Hall, "Cradle of Liberty"

Surviving Dr. Thompson are his wife, Mrs. Phoebe Howe Thompson; a daughter, and a son, Dr. William H. Thompson, at present completing his post-graduate study in radiology.

SYDNEY J. HAWLEY, M.D.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

PRACTICAL X-RAY TREATMENT. By ARTHUR W. ERSKINE, M.D. A volume of 155 pages with 22 illustrations. Published by The Bruce Publishing Company, St. Paul and Minneapolis, 3d edition, 1947.

AN INTRODUCTION TO BIOCHEMISTRY. By WILLIAM ROBERT FEARON, M.A., Sc.D., M.B., Fellow of Trinity College, and Professor of Biochemistry, University of Dublin. Fellow of the Royal Institute of Chemistry. Member of the Royal Irish Academy. A volume of 569 pages. Published by Grune & Stratton, New York, 3d edition, 1947. Price $6.00.

ELECTRONICS AND THEIR APPLICATION IN INDUSTRY AND RESEARCH. Edited by BERNARD LOVELL, O.E.B., B.Sc., PH.D., F. INST. P., Physical Laboratories, University of Manchester. A volume of 660 pages, with 404 illustrations. Published by the Pilot Press, Ltd., London, 1947. Price 42s, net.

Book Reviews

REPORT OF THE CHRISTIE HOSPITAL AND HOLT RADIUM INSTITUTE, MANCHESTER, 1946.

This report of the Christie Hospital and Holt Radium Institute, Withington, Manchester, for 1946, contains a number of interesting photographs of buildings and equipment, and full financial details, and as usual an interesting analysis of the cancer material treated by the Institute.

The types of tumors, classified according to localization, whether primary or secondary, and whether previously treated in other institutions, together with details of the sites, are listed, and the geographical origin of the patients is given, showing that some have come from as far away as the Barbadoes and South Africa.

A summary shows that the work done has doubled since 1938. New patients for 1946 number nearly 6,000, and the total number of treatments has reached approximately 7,000.

Unfortunately, the shortage of paper and lack of free funds have prevented the publication of details of treatment but the report reflects, as in the past, a very large amount of work accomplished and shows extremely valuable co-ordination with nearby institutions in diagnosis and treatment. Now that the War is over we may look forward next year to a fuller record of the work of this remarkable institution by its medical and research staff, headed by the world famous director, Ralston Paterson.

LA RADIOTERAPIA EN CLÍNICA: ELEMENTOS DE FISICA, BIOLOGIA Y TERAPÉUTICA [Clinical Radiotherapy. The Physical and Biological foundations of the Roentgen and Becquerel-Curie rays]. By PROF. DR. ALFONSO C. FRANGELLA, Sub-Director de Instituto de Radiologio de la Facultad de Medicina, Montevideo. Montevideo, "Impresora Uruguaya," S. A., 1942. A volume of 883 pages with 427 illustrations.

This monumental volume of nearly nine hundred pages is well printed, well illustrated, and well arranged, constituting a fountain of information relative to clinical radiotherapy. Tribute is paid to Professor Doctor Pedro A. Barcia and the late Professor Doctor Carlos Butler, and other Uruguayan pioneers.

After a prologue by Professor José A. Saralegui, the author devotes 285 pages to the physics of roentgen and radium therapy. In harmony with the widespread feeling among our Latin-American neighbors that x-rays and radium really should be referred to as the rays of Roentgen and Becquerel-Curie, this terminology is followed throughout the work. The publication of this book antedates the epoch-making discoveries regarding radiation which became public following the use of the atom bomb.

The second part of the work, consisting of about one hundred pages, relates to radiobiology and summarizes our knowledge of the effect of Roentgen and Becquerel-Curie rays on living matter, and especially on the human organism. The remainder of the book includes the clinical therapeutic indications and dosages of x-ray and radium therapy. Numerous illustrations, some in color, illuminate the text. The language is direct, dignified, and a real treat to readers of Spanish.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to cooperate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates. Address: Howard P. Doub, M.D., The Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 607 Medical Arts Bldg., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Hugh F. Hare, M.D., 605 Commonwealth Ave., Boston 15, Mass.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Harold Dabney Kerr, M.D., Iowa City, Iowa.

AMERICAN COLLEGE OF RADIOLOGY. *Secretary*, Mac F. Cahal, 20 N. Wacker Dr., Chicago 6, Ill.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Courtney S. Stickley, M.D., Bell Bldg. Montgomery. Next meeting at the time and place of the Alabama State Medical Association meeting.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and annually at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Sydney F. Thomas, M.D., Palo Alto Clinic, Palo Alto.

LOS ANGELES COUNTY MEDICAL ASSOCIATION, RADIOLOGICAL SECTION. *Secretary*, Moris Horwitz, M.D., 2009 Wilshire Blvd., Los Angeles 5. Meets second Wednesday of each month at County Society Bldg.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually with State Medical Association.

SAN DIEGO ROENTGEN SOCIETY. *Secretary*, R. F. Niehaus, M.D., 1831 Fourth Ave., San Diego. Meets first Wednesday of each month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Ivan J. Miller, M.D., 2000 Van Ness Ave. Meets monthly on the third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Toland Hall, University of California Hospital.

Colorado

DENVER RADIOLOGICAL CLUB. *Secretary*, Washington C. Huyler, M.D., Mercy Hospital, 1619 Milwaukee, Denver 6. Meets third Friday of each month, at the Colorado School of Medicine and Hospitals.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Robert M. Lowman, M.D., Grace-New Haven Hospital, Grace Unit, New Haven. Meetings bimonthly, second Thursday.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Beals, M.D., St. Luke's Hospital, Jacksonville. Meets semiannually, in April, preceding the annual meeting of the Florida Medical Society, and in November.

Georgia

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert Drane, M.D., De Renne Apartments, Savannah. Meets in November and at the annual meeting of State Medical Association.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, T. J. Wachowski, M.D., 310 Ellis Ave., Wheaton. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April, at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly as announced.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, J. A. Campbell, M.D., Indiana University Hospitals, Indianapolis 7. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, Arthur W. Erskine, M.D., 326 Higley Building, Cedar Rapids. Meets during annual session of State Medical Society.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney E. Johnson, M.D., 101 W. Chestnut St., Louisville.

LOUISVILLE RADIOLOGICAL SOCIETY, *Secretary-Treasurer*, Everett L. Pirkey, Louisville General Hospital, Louisville 2. Meets second Friday of each month at Louisville General Hospital.

Louisiana

LOUISIANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Johnson R. Anderson, M.D., No. Louisiana Sanitarium, Shreveport. Meets with State Medical Society.

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets first Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, Oscar O. Jones, M.D., 2622 Greenwood Road. Meets monthly September to May, third Wednesday, 7:30 P.M.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary*, Harry A. Miller, 2452 Eutaw Place, Baltimore.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, at Wayne County Medical Society club rooms.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS. *Secretary-Treasurer*, R. B. MacDuff, M.D., 220 Genesee Bank Building, Flint 3.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, C. N. Borman, M.D., 802 Medical Arts Bldg., Minneapolis 2. Regular meetings in the Spring and Fall.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, John W. Walker, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month, October to May.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, O. A. Neely, M.D., 924 Sharp Building, Lincoln. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary-Treasurer*, Albert C. Johnston, M.D., Elliot Community Hospital, Keene. Meetings quarterly in Concord.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Raphael Pomeranz, M.D., 31 Lincoln Park, Newark 2. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

New York

ASSOCIATED RADIOLOGISTS OF NEW YORK, INC. *Secretary*, William J. Francis, M.D., East Rockaway, L. I.

BROOKLYN ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Abraham H. Levy, M.D., 1354 Carroll St., Bklyn. 13. Meets fourth Tuesday of every month, October to April.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month, October to May, inclusive.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary-Treasurer*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 10. Meetings in January, May, and October.

LONG ISLAND RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Wm. Snow, M.D., 941 Park Ave., New York 28.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary*, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7. Meets at Strong Memorial Hospital, third Monday, September through May.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, James E. Hemphill, M.D., Professional Bldg., Charlotte 2. Meets in May and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Charles Heilman, M.D., 1338 Second St., N., Fargo.

Ohio

OHIO RADIOLOGICAL SOCIETY. *Secretary*, Carroll Dundon, M.D., 1030 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association, May 1948.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Hugh A. Baldwin, M.D., 347 E. State St., Columbus.

CINCINNATI RADIOLOGICAL SOCIETY. *Secretary*, Eugene L. Saenger, M.D., 735 Doctors Bldg., Cincinnati 2. Meets last Monday of the month, September to May.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George L. Sackett, M.D., 10515 Carnegie Ave., Cleveland 6. Meetings at 6:30 P.M. on fourth Monday, October to April, inclusive.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Peter M. Russo, M.D., 230 Osler Building, Oklahoma City. Meetings three times a year.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wm. Y. Burton, M.D., 242 Medical Arts Bldg., Portland 5. Meets monthly, on the second Wednesday, at 8:00 P.M., in the library of the University of Oregon Medical School.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Calvin L. Stewart, M.D., Jefferson Hospital, Philadelphia 7. Meets first Thursday of each month at 8:00 P.M., from October to May in Thomson Hall, College of Physicians, 21 S. 22d St.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Lester M. J. Freedman, M.D., 415 Highland Bldg., Pittsburgh 6. Meets second Wednesday of each month at 6:30 P.M., October to May, inclusive.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., Lincoln Clinic, Lincoln, Nebr.

South Carolina

SOUTH CAROLINA X-RAY SOCIETY. *Secretary-Treasurer*, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

Tennessee

MEMPHIS ROENTGEN CLUB. Meetings second Tuesday of each month at University Center.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frére, M.D., 707 Walnut St., Chattanooga. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth 2. Meetings on third Monday of each month in Dallas in the odd months and in Fort Worth in the even months.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth 4. Next meeting Jan. 17, 1948.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, M. Lowry Allen, M.D., Judge Bldg., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

UNIVERSITY OF UTAH RADIOLOGICAL CONFERENCE. *Secretary*, Henry H. Lerner, M.D. Meets first and third Thursdays, September to June, inclusive, at Salt Lake County General Hospital.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, E. Latan Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Homer V. Hartzell, M.D., 310 Stimson Bldg., Seattle 1. Meetings fourth Monday October through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

RADIOLOGICAL SECTION OF THE WISCONSIN STATE MEDICAL SOCIETY. *Secretary*, S. R. Beatty, M.D., 185 Hazel St., Oshkosh. Two-day meeting in May and one day at annual meeting of State Medical Society in September.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursdays 4 to 5 P.M., September to May, inclusive, Room 301, Service Memorial Institute, 426 N. Charter St., Madison 6.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, E. M. Crawford, M.D., 2100 Marlowe Ave., Montreal 28, Quebec. Meetings in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origéne Dufresne, M.D., Institut du Radium, Montreal. Meets on third Saturday of each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPIA. *General Secretary*, Dr. Dionisio Pérez Cosío, Marsella 11, México, D. F. Meetings first Monday of each month.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

The Musculoskeletal System

Gynecology and Obstetrics

The Genito-Urinary System

THE HEAD AND NECK

Experiences in Ventriculography of Tumours Below the Tentorium. Erik Lysholm. Brit. J. Radiol. **19:** 437–452, November 1946.

This study of subtentorial tumors is based on cases seen in Olivecrona's Neurosurgical Clinic in the Seraphimer Hospital, Stockholm. The greater part of the paper consists of illustrated case reports. Unfortunately the reduction required by printing makes the cuts difficult to interpret, at least to the eye of the abstractor.

Since 1935, 8 verified lesions of the quadrigeminal plate had been seen. Exact localization was made roentgenographically in 3 cases. In 2 cases an expanding process behind the aqueduct, bulging into the posterior part of the third ventricle, was identified. In 3 cases only obstruction to the aqueduct could be seen.

Ventriculography was done in 58 cases of vermis tumors, all verified. In 49 of these there was accurate localization; in 5 the localization was slightly inaccurate and in 4 only an infratentorial tumor was identifiable.

Of 75 cases of hemisphere tumors, there was exact localization in 71; a vermis lesion was diagnosed in 2, and non-specific infratentorial localization in 2.

All but one of 11 tumors of the pons were accurately localized.

There were 33 cerebellopontine-angle tumors, all accurately localized; 21 of these were acoustic tumors. This represents about 10 per cent of the acoustic tumors. The other 90 per cent had bony changes and ventriculography was not required.

Of 93 cases of infrafastigial tumors, 88 were exactly located. Forty-two ventriculograms were negative where an expanding process was suspected in the posterior fossa. In only 5 of these cases was operation done, revealing 2 meningiomas, 1 brain stem tumor, 1 acoustic tumor, and 1 tumor of the fourth ventricle.

SYDNEY J. HAWLEY, M.D.

Cystic Teratomas and Teratoid Tumors of the Central Nervous System in Infancy and Childhood. Franc D. Ingraham and Orville T. Bailey. J. Neurosurg. **3:** 511–532, November 1946.

Fifteen cases of cystic teratoma and teratoid tumor of the central nervous system in children, found among 231 neoplasms of the central nervous system operated upon at the Children's Hospital, Boston, in a twenty-year-period, are reported. No patients over fifteen years of age are admitted to this hospital. Eight of the tumors were intracranial and 7 intraspinal. Craniopharyngiomas and sacrococcygeal teratomas have been excluded from this series, as have chordomas. Dermoid cysts, however, are included.

Intracranial Group: From the clinical point of view, the character of the symptoms and the problems of differential diagnosis of intracranial teratomas and teratoid tumors were those of any space-occupying lesion in that location. There were local effects, depending on the site of the tumor, and pressure effects, resulting from the increase in volume of the cranial contents. Nothing was encountered that would suggest the pathological diagnosis preoperatively unless an associated congenital anomaly was present, which occurred occasionally. The presence of a congenital anomaly in a patient with signs and symptoms of a space-occupying cerebral lesion does not establish the diagnosis of teratoma or teratoid tumor, but increases somewhat the chances of finding this lesion. Roentgenograms of the skull may possibly show calcified areas suggesting the presence of bone or other organoid structures in tumors of this group. In none of the patients in this series was it possible to make a definite diagnosis of the type of lesion roentgenologically. There was evidence of increased intracranial pressure and, in some instances, internal hydrocephalus was present. Ventriculograms or encephalograms demonstrated filling defects indicating the size and location of the tumors. Of the 8 patients with intracranial teratoma or teratoid tumor, 1 is living more than five years after operation; 2 are living for periods less than five years; and 5 are dead.

Intraspinal Group: As with the intracranial teratomas and teratoid tumors, the symptoms produced by the intraspinal members of the series were those of a space-occupying lesion at the level involved. With the intraspinal tumors, however, the association of a congenital abnormality was the rule rather than the exception. Since these anomalies affected the vertebrae, they could be easily demonstrated roentgenologically and often by physical examination as well. The bony defects might or might not occur at the same level as the tumor. They were of considerable importance in suggesting the diagnosis of teratoma or teratoid tumor preoperatively. Usually the anomalies were compatible with normal function of the spine once the tumor had been removed and seldom required operative treatment. Occasionally, also, nevi or pigmented spots in the skin at the level of the lesion were regarded as somewhat suggestive of teratoma or teratoid tumor. Congenital anomalies of other organ systems, such as the cardiac or genito-urinary system, are not regarded as being in any way related to the incidence of intraspinal tumors.

Roentgenograms were chiefly useful in this group of patients' or the demonstration of anomalies of the vertebral column. It is conceivable that a definite diagnosis might be made roentgenologically by the demonstration of calcified organ-like portions of the tumor. As in the intracranial group, no such instance occurred in the present series. Other roentgen studies for further localization and definition of the extent of the growth were made as indicated as with any intraspinal tumor. Of the 7 patients with intraspinal teratomas and teratoid tumors, 2 are living more than five years; 4 are living for periods less than five years; 1 is dead.

THE CHEST

Transverse Laminagraphy of the Chest. Pietro Amisano. Radiol. med. (Milan) **32:** 418–421, November 1946.

The author has applied laminagraphy to the study of transverse sections of the chest. The patient is in a sitting position with the head flexed on the chest and the film is under the thighs. The axis of rotation of the laminagraph is at the level of the chest to be examined. The roentgen rays enter the body at the shoulder level and traverse the whole trunk before reaching the film.

Considering the technical difficulties involved, the laminagrams are surprisingly good.

CESARE GIANTURCO, M.D.

Establishment and Use of Fundamental Procedures in Tuberculosis Control. J. A. Myers. Pub. Health Rep. 61: 1563–1583, Nov. 1, 1946.

This article represents the fruits of twenty-six years' observation on tuberculosis in the city of Minneapolis. It shows the result of carefully planned, long-term studies, which have to be undertaken to evaluate such a chronic disease as tuberculosis. An example of the scrupulously careful work which the author and his cohorts have done is reflected by the tuberculin surveys made in the grade schools. In 1926, 47.3 per cent reacted positively to tuberculin, whereas in 1944, only 7.7 per cent were reactors. Also, the attack rate among six-year old children was reduced from 3.5 per cent in 1926 to 0.33 per cent in 1944.

The application of x-rays to the diagnosis of tuberculosis has undergone numerous changes in the period covered by the report. The adoption of paper film and its application to the photofluorographic technic have solved a problem that at first appeared unsurmountable. In the earlier years there was a considerable discrepancy between the findings on x-ray examination and tuberculin testing, so that two questions arose: "Why do so many tuberculin reactors present no evidence of calcification?" and "Why is so much evidence of calcification reported among non-reactors to tuberculin?" In answer to the first it is pointed out that the foci may be so small as to cast no shadow on the x-ray film or they may be in some part of the chest not readily accessible to x-ray inspection. A partial answer to the second question lies in the possibility that the interpretation is not correct in all cases. The calcification may be due to other causes than tuberculosis, and a tuberculous lesion resulting in calcification may become completely healed and sterilized so as to give no evidence of infection by the tuberculin test. In 1927 McPhedran showed that certain vascular shadows were frequently misinterpreted as calcium deposits and in 1930 all the films obtained up to that date were reinterpreted on this basis.

It was found, after ten years, that x-ray inspection of the chest rarely revealed evidence of significant disease in children under twelve or fourteen years of age, even though they reacted positively to tuberculin, so that roentgen studies in this group were discontinued. The use of stereoscopic films was also discontinued after 1931, since it was found that no significant disease could be detected on one film of a stereoscopic pair that was not equally discernible on the other.

The ten-year data also revealed that no phase of the examination had resulted in the discovery of a single proved case of tuberculosis among non-reactors to tuberculin. From 1921 to 1941, 5,968 children who were non-reactors to tuberculin were observed. In 95.6 per cent, no evidence of disease of any kind was detected by x-ray film of the chest. In the remaining 4.4 per cent, there was only evidence of pleural changes, calcium deposits, and non-tuberculous pulmonary disease. Among 4,377 reactors, on the other hand, only 58.1 per cent had films that were entirely clear. The remaining 41.9 per cent gave evidence of pleural changes, primary lesions in the pneumonic or atelectatic stage, calcification, non-tuberculous pulmonary disease and pulmonary tuberculosis of the reinfection type. For this reason chest x-ray examinations of non-reactors were discontinued.

Between 1921 and 1926, 1,033 children who were reactors were observed. Fifteen, at the average age of fourteen years, showed evidence of reinfection type pulmonary tuberculosis. Nine of these died at the average age of twenty. By 1941, 41 other cases of pulmonary tuberculosis of the reinfection type were seen, with 14 deaths at an average age of twenty-two. It is thus obvious that a positive tuberculin reaction in childhood makes mandatory a long and careful follow-up with x-rays. In spite of the great value of x-rays, it is strongly recommended that "no one—roentgenologist, pediatrist, internist, surgeon, or chest specialist—attempt to diagnose any pulmonary pathologic condition by x-ray," while "to attempt to determine the activity of tuberculous lesions by a single x-ray shadow is preposterous." There are but two ways to diagnose tuberculosis, (1) the finding and identification of the tubercle bacillus and (2) the tuberculin reaction.

Of the many persons observed in the Minneapolis work, more than 1,000 adults—mostly students of nursing and medicine—have developed primary tuberculosis while under observation. They have tolerated the first infection type of tuberculosis as well as have those infected in childhood; and, moreover, they have not developed, subsequently, significant chronic reinfection type of tuberculosis to a greater degree than have those who entered the observation group as tuberculin reactors. The theory propounded in 1920, therefore—that a first infection postponed to adulthood is exceedingly hazardous—is untenable.

When shadows of lesions which were thought to be tuberculous were seen in children and young adults who were apparently in excellent health and presented no other symptoms other than a positive tuberculin reaction, it was assumed that the majority of these lesions represented clinical disease that would progress, causing illness and death, if not promptly and adequately treated. As the years passed, the fact became apparent that all reactors to tuberculin have lesions of the primary type, determinable as to location in only a small percentage during life. Observation of such children under different conditions showed that whether they received sanitarium care or remained at home, there was no difference in the morbidity or mortality when the cases were reviewed some years later. [Actually the prime necessity for hospitalizing those with primary tuberculosis is to remove them as a focus of infection or to give them the advantage of a better environment and better nutrition with which to cope with this disease.]

In the course of many surveys, so-called benign shadows are often seen and Dr. Myers feels that serious injustice could result from a recommendation of treatment for every lesion found on the first examination, as many of them, regardless of size, have long since been controlled by the body defense mechanism, and therefore require no treatment. Unfortunately, the status usually cannot be determined except by extended observation, and as age advances there is an accrual of minimal lesions that have come under control. These may be of long standing. Hence, not all minimal lesions are early.

In conclusion, Dr. Myers says that inexpensive x-ray inspection of the chest of each adult would reveal practically everyone who, at the time, has infectious tuberculosis. Those who react to tuberculin on the first test, and those who are later found to be reactors, should have a thorough annual examination and be

isolated in hospitals and sanatoria if the disease becomes infectious. The responsibility for these accomplishments lies with those in charge of the public health. Failure to achieve them—failure to control completely and ultimately to eliminate tuberculosis—is unpardonable.

[No mention is made of the case which is first seen as a minimal case but may have in the past been a moderately advanced or advanced case. These are the cases of minimal disease which are much more likely to break down than are lesions which were actual minimal to begin with. In this way, the x-ray shadows may be misleading, and when minimal arrested lesions are seen, one must keep in mind the possibility of a formerly existing more advanced lesion.—S. F. T.]

SYDNEY F. THOMAS, M.D.

Tuberculosis—A Labor Problem. Leo Price. Am. Rev. Tuberc. **54:** 512–526, December 1946.

The author discusses some of the social and economic problems of tuberculosis as it affects the average worker. The laboring man often shuns tuberculosis case-finding programs because he knows the discovery of the disease in himself means the loss of a job, hospitalization, impoverished dependents, and trouble in finding work after the disease is stabilized. The experience of the Ladies Garment Workers Union in establishing a tuberculosis insurance program is discussed in considerable detail. This union, which now numbers 165,000 members in New York City, began such a program in 1913. In 1942, union contracts first contained a clause requiring the employers to pay a tax on the pay roll for health aids to employees. With these funds, improved medical service for garment workers became possible. Members of the union co-operate with x-ray surveys for the detection of tuberculosis because of the assurance that the victims of the disease will receive medical and economic support. A long-range tuberculosis control program sponsored by industry should consist of periodic x-ray examinations, sanatorium care and financial aid for tuberculous patients, rehabilitation in sheltered workshops and medical supervision of all workers who have ever had the disease. L. W. PAUL, M.D.

Cancer and Pulmonary Tuberculosis. Diagnostic Problems in Patients with Cancer of the Lung in the Presence of Pulmonary Tuberculosis. Bruno Gerstl, Frederick C. Warring, Jr., and Kirby S. Howlett, Jr. Am. Rev. Tuberc. **54:** 470–487, December 1946.

Since January 1940, 7 cases of coexisting bronchiogenic carcinoma and pulmonary tuberculosis have been recognized at Laurel Heights Sanatorium, Connecticut, among approximately 1,600 patients sent in with a diagnosis of pulmonary tuberculosis only. The present report summarizes the findings in these cases.

In only one instance did the diagnosis of tuberculosis present a problem; in the remaining cases the diagnosis was readily apparent and was promptly confirmed by the finding of tubercle bacilli in the sputum. The detection of the cancer was more difficult. The clinical evidences of cancer tended to be masked by the symptoms and signs of tuberculosis. The x-ray findings were of greatest significance in at least causing a suspicion as to the presence of another disease. When true hilar infiltration is demonstrated on postero-anterior and lateral films, cancer should be suspected, since this is seldom seen in reinfection tuberculosis. Evidence of major bronchial obstruction or of a relatively circumscribed mass should also arouse a suspicion of the coexistence of carcinoma, especially in older patients. When such suspicion is aroused, the well known diagnostic procedures available for confirmation of carcinoma should be employed, including bronchoscopy, biopsy of suspected metastatic lesions, needle biopsy, etc.

None of the cases reported was deemed operable at the time of diagnosis but, since pulmonary resection is now feasible in many cases of tuberculosis, the practical desirability of earlier diagnosis of coexisting cancer is apparent. L. W. PAUL, M.D.

Mass Miniature Radiography. A Survey in the United States Army Air Forces. Edgar Wayburn. Am. Rev. Tuberc. **54:** 527–540, December 1946.

During 1945 a mass x-ray survey of the chest was conducted on 77,480 persons in the United States Army Air Forces in England, by means of two mobile trailer units. The results of the survey are presented in a series of tables and charts. In this select group there was found 0.006 per cent of active primary tuberculosis, 0.08 per cent of active reinfection type tuberculosis, and 0.26 per cent of healed reinfection type tuberculosis. Chest conditions of clinical interest other than tuberculosis were found in 76 cases. There was nothing in the survey to suggest that flying predisposes to pulmonary tuberculosis in previously healthy young men. L. W. PAUL, M.D.

Endogenous versus Exogenous Origin of Reinfection Type Pulmonary Tuberculosis. With Case Report. William H. Harris, Jr. U. S. Nav. M. Bull. **46:** 1702–1707, November 1946.

"Reinfection tuberculosis" is a term applied to that form of the disease which occurs after a primary lesion has been sustained. It has also been termed "adult type tuberculosis," "secondary infection," and "superinfection." As applied to reinfection tuberculosis, "endogenous origin" indicates that the bacilli causing the disease process have been derived from an old primary infection, and "exogenous origin" implies that the causative organisms have come from an outside source. The exogenous route is generally considered to be of greater frequency and of greater importance.

A case of reinfection pulmonary tuberculosis is reported here, with x-ray evidence and lack of outside contacts strongly suggesting an endogenous origin. Roentgenograms are reproduced which indicate a breaking down of an old calcific hilar lesion, permitting a spilling of viable bacilli, which were believed to be responsible for the reinfection. The role of atypical pneumonia in the excitation of latent primary lesions with resultant endogenous reinfection is emphasized.

Lung Lesions in Skeletal Tuberculosis. Review of 500 Cases. K. J. Mann. Lancet **2:** 744–749, Nov. 23, 1946.

In an investigation of the respiratory tract in 500 patients with skeletal tuberculosis, 284 cases (57 per cent) of active pulmonary tuberculosis were found. The history, symptoms, signs, and bacteriologic studies were of little assistance in discovering early lung involvement and it was necessary, therefore, to rely on roentgen examination for diagnosis and classification of pulmonary lesions. Roentgenograms were taken on admis-

sion and repeated at three-month intervals. In children "negative" roentgen findings were not taken as final, and in a number of instances the primary lung infiltration, which was not visible in the first roentgenogram, became apparent in later films. The type of lesion varied according to age. The primary complex was found in most of the children, and hematogenous foci were the rule in adults. The respiratory tract thus appears to be the route of entry even in tuberculosis of the bones and joints. The skeletal lesion in most children originates soon after the primary infection. In adults it is usually due to reactivation of quiescent tuberculous foci resulting in blood-stream dissemination and subsequent implantation in bone and lung.

The importance of routine roentgenography of the chest in the diagnosis and prognosis of skeletal tuberculosis is emphasized.

Extrapleural Pneumothorax in Silico-Tuberculosis. H. M. Maier and A. Hurst. Am. Rev. Tuberc. **54:** 509–511, December 1946.

A case of silico-tuberculosis is reported in which extrapleural pneumothorax was instituted and resulted in prompt closure of a tuberculous cavity. The method is recommended for trial in cases of this type, since it is a reversible procedure and since other methods of collapse therapy often cannot be employed in silico-tuberculosis.

L. W. PAUL, M.D.

Pneumatocele During the Course of Pneumonia in Children. John Roger Almklov and Alexander Hatoff. Am. J. Dis. Child. **72:** 521–528, November 1946.

A cavity with a sharply defined thin border and often an air-fluid level is a fairly frequent roentgenologic finding during the course of pneumonia in children. To designate this, the authors prefer the term "pneumatocele" to emphysematous bulla or benign cavity.

Normally, the bronchial tree dilates in inspiration and is constricted in expiration. When inflammatory swelling of the bronchial mucosa accompanies pneumonia, it may lead to a check-valve action, allowing more air to enter during inspiration than can pass out in expiration, and an obstructive emphysema results.

The diagnosis of pneumatocele is usually made on roentgen study. Conditions to be differentiated are acute pulmonary abscess, aputrid pulmonary necrosis due to infarction, tuberculous cavity, loculated pneumothorax, and congenital pulmonary cyst (Caffey: Am. J. Dis. Child. **60:** 586, 1940). Acute pulmonary abscess develops and heals slowly and is accompanied by foul sputum, fever, clubbed fingers, and other signs completely absent in pneumatocele. Tuberculous cavities are ruled out by negative reaction to tuberculin and uneventful course. Loculated pneumothorax may be excluded by lateral and oblique chest films. Congenital pulmonary cysts are demonstrable before, during, and after the course of pneumonia, whereas pneumatocele is not usually present on the first films and disappears during the course of the disease.

Pneumatocele rarely produces symptoms or signs and in uncomplicated cases requires no treatment.

The authors saw 7 cases of pneumatocele in 50 children with pneumonia in a one-year period. Five of the patients had lobar pneumonia and 2 bronchopneumonia with localization in the middle portion of the right lung field. The pneumatocele invariably occurred in the area involved by the pneumonia. The time of appearance varied from the second to the twenty-fifth day after onset of the disease. In 3 of the 7 cases more than one pneumatocele developed. The lesions varied from 1 to 3 cm. in diameter. Fluid levels were seen in 5. The pneumatoceles were observed from four to forty-one days from date of appearance to disappearance. All disappeared spontaneously and completely without special treatment of any kind directed to the pneumatoceles.

BERNARD S. KALAYJIAN, M.D.

Bronchial Adenomas. Sion W. Holley. Mil. Surgeon **99:** 528–554, November 1947.

Bronchial adenomas constitute approximately 8 to 10 per cent of all primary bronchopulmonary neoplasms. They usually occur in the third and fourth decades; hence they have been encountered with relative frequency in the larger Army hospitals. The favorable outcome to be anticipated in these cases is in decided contrast to the grave prognosis in bronchiogenic carcinoma, but early diagnosis is essential for proper treatment. This study is based upon records and specimens from 39 cases at the Army Institute of Pathology. Seven cases from this number are presented to illustrate various clinical and pathologic features of the tumor.

Fourteen of the patients were female; 25 were male. The neoplasm was discovered during life in all but one instance, in which a 6-mm. nodule of the carcinoid type was found after death from hypertensive heart disease. Cough was a symptom in 66 per cent of cases; hemoptysis (including blood-streaking as well as severe hemorrhage) in 44 per cent; expectoration in 40 per cent; some form of chest pain, usually mild, in 36 per cent; fever in 36 per cent; dyspnea in 20 per cent; weight loss in 11 per cent; and wheeze in 9 per cent. Thirty-three per cent of the patients had had one or more attacks of acute pulmonary infection, apparently secondary to bronchial obstruction. Roentgenographically the tumor was demonstrable in 8 cases, atelectasis in 16, and inflammatory infiltration in 9 others. The affected bronchus was partially or completely obstructed in 19 cases. Bronchoscopic biopsy was performed in 34 cases, resulting in immediate diagnosis of adenoma in 18, the same diagnosis after additional biopsy or review of the original sections in 5, carcinoma in 14, cylindroma in 1, and endobronchial sarcoma in 1.

The tumor was removed bronchoscopically in 9 cases. There were 11 lobectomies, with two lobes of the right lung removed in two instances. Pneumonectomy was performed in 15 cases.

Three of the 38 patients in whom the tumor was diagnosed during life have since died. At the last follow-up examinations of the remaining patients, there was local recurrence in one; hepatic metastases were found at laparotomy in another. In one patient, with a mixed-tumor type of bronchial adenoma, no further attempt at removal was made after the original bronchoscopy. This patient had had partial collapse of the right lung and bloody pleural effusion for three years. The last roentgenogram showed rounded pleural densities which might be interpreted as tumor nodules. The longest period of observation after operation was ten years. Nothing is known of 3 patients after the immediate postoperative period.

The tumors were located at or near the pulmonary hilus, were usually polypoid, and in several instances attained rather large size. They assumed two distinct patterns, one which simulated that of appendiceal carcinoid and the other that of some of the mixed tumors of

salivary glands and other structures of the mouth and face. The origin of neither of the types was determined, though their intramural location in the bronchus suggests bronchial glands or ducts as sources. Several of the tumors showed features of malignancy; some had infiltrated locally.

This study indicates that lobectomy or pneumonectomy, according to the location of the tumor, is the preferred treatment (1) because many of the tumors are of such size or have infiltrated so that they cannot be entirely removed through the bronchoscope, (2) because of the malignant potentialities of some of the tumors, and (3) because of the frequent coexistence of bronchiectasis and chronic pneumonitis.

Broncholithiasis. John H. Barrett. Arch. Otolaryng. **44:** 574–580, November 1946.

A case of broncholithiasis is recorded. The patient's illness began with influenza in December 1943. This was followed by a persistent cough and then pneumonia in October 1944, which was treated with penicillin, with relief of all symptoms but the cough. In February 1945 the fever recurred and the cough became severe. A month later a sharp pain in the chest developed, and the patient had a severe paroxysm of coughing and raised a large amount of bright blood. Roentgen examination revealed consolidation of the middle lobe of the right lung, with some irregular diminished aeration in the anterior portion of the lower lobe. The right diaphragm was elevated. The heart was displaced slightly to the right but was otherwise normal. There was a dense calcification measuring 1 by 1.4 cm. in diameter just to the right of the mid-line in the region of the right main stem of the bronchus. The changes in the middle lobe of the right lung, with cardiac displacement, suggested an atelectatic process with infection. On bronchoscopy, a calcareous mass surrounded by granulation tissue was found to obstruct the lumen of the right main bronchus, just above the orifice of the middle lobe. This was removed and proved to be a grayish white, rough, irregular calculus about 1 cm. in diameter. On further questioning the patient recalled coughing up a similar but smaller calcified mass, which, however, had not been shown to the attending physician

Primary Endothelioma of the Pleura. Herman Weissman. Dis. of Chest **12:** 562–570, November-December 1946.

Primary endothelioma of the pleura is a rare neoplasm, and its early diagnosis saves the patient a great deal of ineffectual therapy. The onset is gradual and usually becomes apparent following a respiratory infection. Pain appears early and is intermittent in the beginning, gradually becoming constant and gnawing. Usually it is not affected by respiration or cough and is not relieved by fluid formation or aspiration. An idiopathic pleural effusion after middle age may be the first clinical manifestation. Dyspnea and a dry irritating cough progress as the disease advances. The physical findings are those of a pleural effusion. On aspiration, the needle encounters great resistance as it passes through the pleura. Other signs may appear, as clubbing of the fingers, unilateral or bilateral vocal paralysis, dilatation of the thoracic veins, etc. The course is brief, with progressive cachexia, weakness, increasing dyspnea, cyanosis, coma, and death.

The x-ray findings are helpful, but not in the early stages. After thoracentesis, a pneumothorax should be induced. The characteristic findings are multiple smooth tumor nodules of varying sizes and thickness, mostly over the parietal pleura.

The author gives historical and statistical data, quotes Ewing and others as to the origin of the tumor, and presents two case histories; in one the diagnosis was verified postmortem, and in the second by a biopsy.

HENRY K. TAYLOR, M.D.

Mediastinal Alterations Secondary to Hypertrophy of the Left Auricle: Stratigraphic Study. Pietro Perona and Franco Hueber. Radiol. med. (Milan) **32:** 440–448, November 1946.

The authors have studied the angles formed by the two main bronchi with the trachea in normal sthenic and hyposthenic individuals. The average angles found for sthenic types are between 35° and 42° for the right bronchus, 39° and 43° for the left bronchus. The average angles for hyposthenic types are 30° to 33° for the right bronchus and 34° to 36° for the left bronchus.

In patients with hypertrophy of the left auricle, the authors found a widening of the angle between the trachea and the bronchi as well as some compression of the bronchi, with reduction of their volume.

CESARE GIANTURCO, M.D.

Radiological Visibility of the Normal Thymus. Enrico Benassi. Radiol. med. (Milan) **32:** 413–417, November 1946.

According to MacNeil, Hardy, Little, and Blakfan, a large upper mediastinal shadow will be found in 50 per cent of the infants examined by roentgen rays. The author has found large upper mediastinal shadows in many infants referred because of other complaints and ascertained that the widening of the mediastinum was due to the thymus, since the width decreased following irradiation. The author believes that the size of the normal thymus varies between wide limits, and that roentgen therapy should be used only in those cases in which there are definite symptoms of obstruction.

CESARE GIANTURCO, M.D.

Roentgen and Cardiac Manifestations of Funnel Chest. J. George Teplick and E. H. Drake. Am. J. Roentgenol. **56:** 721–735, December 1946.

Funnel chest is not a rare condition but, since most persons having this deformity are without troublesome symptoms, only a small number of cases have been reported. The authors present 9 cases and discuss the salient clinical, roentgenographic, and electrocardiographic features.

The malformation is a developmental anomaly in most instances and is often noted in more than one member of the same family. Severe rickets may produce the deformity, although pigeon chest is a more common result of that disease. Severe trauma to the sternum with an angulated fracture is also an etiologic factor. The condition is due to posterior displacement of the sternum, the manubrium not usually being involved. The depression of the body of the sternum may amount to 7 cm. or more. The heart is usually shifted toward the left, and cardiac rotation in the sagittal plane may be present. The left border of the heart shows some elevation from the diaphragm, resembling a right ventricular enlargement. The right cardiac

border is usually hidden by the vertebral column, and hence an erroneous diagnosis of cardiac enlargement may be made. The right hilar shadows, normally obscured by the overlying right cardiac border, may appear unusually prominent. From these findings a presumptive diagnosis of funnel chest can be made in the absence of other lesions which might cause a left cardiac shift, such as scoliosis, left pleural thickening, left-sided atelectasis, right-sided pleural fluid, and tumors. The lateral view confirms the presence of the deformity.

Several instances of electrocardiographic abnormality occurring in association with funnel chest have been reported. Right axis deviation is a frequent finding; left axis deviation is less common. All varieties of T-wave change, including voltage elevation, peaking, and diphasic and negative complexes, have been reported. ST elevation of minimal degree has been noted. The PR interval is usually unchanged. The changes occurring in the chest leads have not previously been reported. The authors found T-wave changes in lead CF-4 to be the most constant variation in their series.

Disturbances of rhythm occurring in association with funnel chest are uncommon. One of the authors' patients presented a bigeminal rhythm due to regularly recurring right ventricular extrasystoles. This was attributed to an irritable focus in the right ventricle resulting from the constant pressure of the deformed sternum in this region.

Symptoms of a serious nature are uncommon. Palpitation and dyspnea on exertion are the most common complaints. Chest pain occurred in 4 of the cases but was not of the type usually associated with organic heart disease. Significant cardiac physical findings were present in only one case. The blood pressure was within normal limits with the exception of a slight systolic elevation in one patient. Slight cyanosis of the nail beds was observed in two cases.

Surgical treatment is indicated only in a few cases in which there are clear-cut findings of increased cardiac embarrassment not attributable to other conditions.

H. H. WRIGHT, M.D.

Heart Disease in the Case-Finding Program. Howard F. West. Am. Rev. Tuberc. **54:** 465–469, December 1946.

In the interpretation of films made during mass surveys of the chest, alteration in the size and shape of the heart and great vessels may be detected and should be reported. When miniature films are employed, accurate measurements of size may be difficult to make, but methods have been suggested which may be useful in borderline cases. In a recent survey made by the Heart Division of the Los Angeles Tuberculosis and Health Association of 8,933 industrial workers, the 4 × 5-inch films were interpreted as suspicious for heart disease in 151 instances. At the time of analysis, 116 of these persons had been studied clinically and in approximately 75 per cent clinical confirmation of heart disease was obtained.

Since a considerable portion of cases of unsuspected heart disease can be recognized by essentially the same technic used in finding early tuberculosis, it is important to decide what use can and should be made of this information. It is suggested that the National Tuberculosis Association and the American Heart Association establish a joint committee to consider the problem of joint case-finding in its entirety. Standards of procedure, technical, clinical and social, can be adopted for the guidance of local groups in the field.

L. W. PAUL, M.D.

Study of Blood Currents Within the Heart. Adamo Grilli. Radiologia (Rome) **2:** 249–292, 1945.

The author has had the opportunity of observing 2 cases of free intraventricular bullets in which the movement of these foreign bodies gave a good indication of the action of the blood during a normal cardiac cycle. These patients were studied fluoroscopically and with kymographs obtained by means of fixed and moving grids, and the existence of whirlpools and eddy currents was clearly demonstrated.

CESARE GIANTURCO, M.D.

THE DIGESTIVE SYSTEM

Roentgenologic Examination in Patients with Bleeding from the Gastrointestinal Tract. Richard Schatzki. New England J. Med. **235:** 783–786, Nov. 28, 1946.

The routine procedures in examination of patients with gastro-intestinal hemorrhage will vary with the patient and the history at the time of bleeding. Very often the best procedure is a scout film of the abdomen followed by examination of the large bowel. Since massive hemorrhages are in the majority of cases from the upper gastro-intestinal tract, it is often advisable to examine only this portion.

In recent years, examination of the upper gastro-intestinal tract at an early date after bleeding occurs has been an accepted procedure. It may be done within twenty-four to forty-eight hours of the initial bleeding or shortly thereafter. Shock is, of course, a contraindication to examination, but this is not true of active bleeding in itself, since there is no reason to believe that the watery suspension of barium sulfate is as dangerous as food.

The patient should be first placed on his back rotated slightly to the left. A single swallow of barium, if followed fluoroscopically through the esophagus, may reveal the presence of varices. Two or three additional swallows will outline the posterior part of the gastric fundus. With rotation to the right, the antrum and possibly the duodenal bulb will be observed, after which the patient may again be rotated to the left, in which position the barium-coated gastric wall will be outlined with air displaced from the fundus. Examination of the esophagus in both oblique diameters is completed with the patient prone. The duodenal bulb is examined in the same manner. Very often the cause of the bleeding will be found in this part of the examination, in which case further study is unnecessary. Palpation is omitted and the peristaltic activity with rotation of the patient is utilized to bring out any significant lesion. Additional barium may be needed to fill the stomach completely and give adequate definition to the distal portion. Occasionally ulcers in the fundus may be seen best in the right oblique view, while those of the antrum and the duodenal bulb may be best seen in the left oblique projection. The patient may then be turned in the prone position, where the lesser curvature and duodenal bulb are more adequately defined. The second and third portions of the duodenum should be carefully observed and, if no source of bleeding is discovered, the meal should be followed through the small bowel at appropriate periods.

When the source of bleeding has not been found, re-examination at a later date, when palpation is possible, should be made. In spite of all the maneuvers that roentgenologists may practise, the source of bleeding may not be discovered.

The most frequent cause of bleeding is duodenal ulcer, and careful examination of the duodenal bulb is imperative. Gastric ulcers may also cause bleeding and, if they are small, may disappear within a two week period. Cancer of the stomach may be the source of bleeding but a large blood clot may simulate a polypoid tumor. Re-examination would exclude this possibility. The bleeding may be from varices of the esophagus, and these are sometimes hard to demonstrate. They may be present even in the absence of splenomegaly, ascites, and a palpable liver. The varices may be demonstrated only after the bolus of barium has passed through the esophagus and while it is outlined by a thin coating. The diagnosis of gastritis as a source of bleeding is difficult, and is possible in only a small number of cases. Hemorrhage may result from a hiatus hernia. Repeated hemorrhages may occur in the presence of submucosal tumors, such as leiomyoma, fibroma, and neurofibroma of the stomach.

Lesions of the small bowel and colon are not considered in this discussion. JOHN B. MCANENY, M.D.

Gastrocolic Fistula: A Clinical and Experimental Study. R. John F. Renshaw, Frederic E. Templeton, and Robert M. Kiskaddon. Gastroenterology **7:** 511–521, November 1946.

Gastrocolic fistula is one of the most serious complications of surgical treatment for peptic ulcer. The fistula produces a devastating syndrome characterized chiefly by diarrhea, steatorrhea, weight loss, anemia, and malnutrition. Because of the conflicting opinions about the physiological cause of the syndrome and because the shunt mechanism or by-passing of the small intestine did not seem to afford an adequate explanation, the authors made gastrocolic, gastrojejunocolic and enterocolic anastomoses in dogs, observed the results, and compared them with observations in human patients having similar fistulas.

Between 1921 and 1946, 20 patients with proved gastrocolic fistulas were seen at the Cleveland Clinic. Ten of the 20 patients had roentgen studies with sufficient evidence for analysis of direction of the flow of barium. Eight of these 10 patients had fistulas following operation for peptic ulcer. The roentgen studies revealed that the barium meal passed from the stomach into the upper small intestine. In 2 of the 10 patients, a small or minor portion of the meal passed through the fistula into the colon, while the major portion passed from the stomach into the upper small intestine. In the other 8 patients the entire meal passed from stomach to small intestine and none went directly from stomach to colon. It is significant that all or the larger part of the meal always passed into the upper small intestine and was never shunted or dumped directly into the colon.

Seven dogs with gastrocolic or enterocolic anastomoses 1 to 4 cm. in diameter had diarrhea, steatorrhea, anemia, and malnutrition similar to the syndrome occurring in human beings with gastrocolic or gastrojejunocolic fistulas. In all the animals roentgenologic studies revealed that all or the major part of the barium meal passed from the stomach into the upper small intestine. In one dog the barium meal was observed to pass from stomach into small intestine, then into the colon, and finally regurgitate through the fistula back into the stomach from, which it then passed into the upper small intestine again. In another dog fecal material flowing from the colon into the stomach through the fistula was observed at gastroscopic examination.

In one human patient with gastrojejunocolic fistula the barium meal was observed to pass through the pylorus and fistula. Twenty-four hours later most of the barium was still scattered through the small intestine and colon. The stomach contained more barium at twenty-four hours than at five hours, indicating regurgitation through the fistula back into the stomach.

Five dogs which were killed during the course of the syndrome or died as a result of the syndrome showed pathologic changes in the stomach of an inflammatory nature. Two dogs showed gastric ulceration with evidence of organization and some degree of chronicity. In the small intestine, especially the upper third, there was a striking subacute to chronic type of inflammatory infiltration limited almost exclusively to the mucosa of the papillae.

Tentative conclusions based on the above evidence and observations of others are: (1) Sufficient aliment passes from stomach into upper small intestine to maintain adequate nutrition. (2) Passage of aliment directly from stomach to colon is not frequent enough nor in large enough amounts to produce the syndrome. (3) Deranged digestive and absorptive functions of the small intestine cause the syndrome. (4) Derangement of small intestinal function is probably the result of damage to the intestinal mucosa by passage of colonic contents through the small intestine.

Redundant Duodenum. A Radiographic Study. Irwin H. Slater and Arthur Lautkin. U. S. Nav. M. Bull. **46:** 1651–1657, November 1946.

The superior portion of the duodenum is usually a short segment which proceeds posteriorly and to the right to form the first part of the normal horseshoe-shaped duodenum. Occasionally there is elongation of this segment, producing a U- or V-shaped redundancy demonstrable on roentgen examination. In a series of 1,000 consecutive gastro-intestinal examinations at a naval hospital, 22 cases (2.2 per cent) of redundant duodenum were found. In most of the cases in this series the segment was mobile.

The V-shaped tract shows no dilatation and usually has an entirely normal mucosal pattern. The U-shaped loop, however, is dilated and, as a rule, presents a water-trap appearance. This segment often seems to retain the barium for a short interval in its relatively wide channel, giving an appearance of "puddling" which is transient and not to be confused with retention. In no case in the series reported here was prolonged retention or even significant delay in the emptying of this segment observed. The barium meal passed normally through the duodenum and in no instance was an empty stomach associated with anything but an empty superior duodenum.

Chronic duodenal obstruction may, however, be associated with dilatation and elongation of the superior duodenum. In these cases, a U-shaped redundancy has been noted. This should be differentiated by its obstructive concomitants—gastric retention and failure of normal progress of the meal into the jejunum.

Elongation of the superior duodenum may be associ-

ated with changes in the bulb that simulate the changes seen in peptic ulcer. One of the disturbing features of the lesion is the rapidity with which a partially filled duodenal cap spills into the descending loop of the redundancy. This should not be confused with irritability or deformity with failure of filling. In the erect position, flattening or peaking at the cap may occur because of the traction of the mobile U-shaped loop. At the angle formed by the bulb and the descending limb of the redundancy, the mucosal folds overlap and interlace. A stellate mucosal pattern at this point may be analogous to the stellate formation often seen at the superior angle of the normal duodenum. In the case of the redundant duodenum, this shadow may occur close to the pylorus and is likely to be interpreted as a crater or scar. A large, flaccid bulb often has much the appearance of a redundancy of the superior duodenum, but careful observation of the progress of the barium should settle this problem.

In each case careful scrutiny of the bulb itself must be made so that the apparent deformity and irritability associated with redundancy of the superior duodenum will not be confused with intrinsic duodenal disease.

In the entire series of 1,000 gastro-intestinal examinations, there were 248 instances of definite disease in the stomach or duodenum. This includes ulcers and cancers but not gastritis or duodenitis. Six of the 22 patients with elongation of the superior duodenum showed a defect in the stomach or duodenum. Since the figures in each group approximate 25 per cent, the authors believe that "the redundant duodenum is not a contributing factor to either gastro-intestinal pathology or symptomatology."

Amebic Disease of the Cecum: Clinical and Radiological Aspects. Dwight L. Wilbur and John D. Camp. Gastroenterology **7:** 535–548, November 1946.

Amebiasis frequently involves the cecum and presents a variety of clinical pictures simulating a variety of cecal and appendiceal lesions. Symptoms may be absent. Some of the patients in the authors' series with amebiasis had had a previous diagnosis of acute appendicitis, appendiceal abscess, and carcinoma of the cecum. The frequency with which the diagnosis of acute appendicitis is made in these cases is of great importance because of the disastrous results of surgery (the mortality following surgical therapy incident to the Chicago epidemic of 1933 was 40 per cent).

In the authors' experience, roentgen examination of the colon was the most valuable method of indicating the presence of amebic disease. In numerous instances the diagnosis was suspected or made by the roentgenologist when there were no clinical symptoms, in cases with or without cysts or trophozoites in the stool. The significant roentgenologic changes in the cecum consist of spasm, dilatation, relaxation and abnormal patency of the ileocecal valve, inflammatory induration with "coning," and inflammatory tumefactive defects. The earliest lesions are those involving the mucosa; the cecal walls lose their sharp smooth character and the mucosa appears finely granular or of irregular contour and there may be associated cecal spasm. Cecal lesions of amebiasis were found by barium enema studies in 9 of 37 patients with stools which on routine examination contained cysts or trophozoites of *Ameba histolytica*. Roentgen examination was particularly useful in indicating the diagnosis of amebiasis in patients with a history suggesting previous disease of the appendix and in those with hepatitis otherwise unexplained, enlarged livers, and abscesses of the liver, when no amebae or cysts could be found in the stools or pus.

With the return of military personnel from heavily infested areas, a considerable number of cases of amebiasis will be observed in the United States, and clinicians and roentgenologists should be on the alert for signs of this disease.

A Concept of Paralytic Ileus: A Clinical Study. John Devine. Brit. J. Surg. **34:** 158–179, October 1946.

Paralytic ileus is of three types: (1) idiopathic paralytic ileus; (2) paralytic ileus arising from medical diseases; (3) paralytic ileus the result of surgical operations. A number of brief case histories are given illustrating these three types. The pathological physiology is reviewed and the author quotes Wangensteen (1942), who showed that a pressure of 55–65 mm. Hg within the gut causes pressure on the veins encircling the ileum. This interferes with the absorption of gas and fluid and leads to more distention. The effects of distention may be local or general. One local result is increased permeability of the capillaries of the intestinal mucosa with transudation of some of their contents into the peritoneal cavity. There is a resulting loss of plasma from the circulation with decrease of bowel motility probably from associated edema of bowel. Among the general effects is diminished flow of bile. In most of the cases studied by the author there was little or no sign of bile in the aspirated fluid. In a fully developed paralytic ileus the large intestine is also involved and enemas are retained or returned without result.

In a lengthy discussion of various treatments of paralytic ileus the author enumerates those drugs and procedures which are used to increase motility, and reviews the literature on the action of morphine on the small intestine—a drug frequently used not only for its action on the muscle of the small intestine, but also for the induction of sleep and relief of pain. In 3 cases tracings and observations were made on patients with the Miller-Abbott tube and recording tambour. The results of these and other investigations seem to show that morphine: (1) delays the passage of food through the intestine and therefore causes constipation: (2) causes duodenal spasm for a short time followed by relaxation: (3) decreases peristaltic movement of the duodenum and ileum, but (*a*) increases the tone and (*b*) the frequency of the small mixing waves. Cases treated with the barbiturates were also studied by means of a recording Miller-Abbott tube and it is concluded that they should be given with caution in cases of possible paralytic ileus as they decrease peristalsis and tone.

Coincident pathological conditions which may contribute to the occurrence of postoperative paralytic ileus are hypoproteinemia, distention of the upper urinary tract or bladder, intraperitoneal irritation, and over-distention of the stomach.

The author develops a concept of ileus based on clinical study employing auscultation of the abdomen and the Miller-Abbott tube with recording tambour. According to this concept, there are three stages of ileus: (1) the stage of no movement; (2) a stage of disordered and inco-ordinated movement; (3) a stage when movement is being co-ordinated once more. Stimulation by enemas, pituitrin or by other measures in the second stage causes more distention and increased pain and discomfort for the patient. In the third stage

these same measures produce a result with relief of symptoms. The treatment of a fully developed paralytic ileus consists of the use of the Miller-Abbott tube and replacement therapy. In cases where the tube cannot be passed or does not go beyond the pylorus, introduction may be made through a jejunostomy.

MAX CLIMAN, M.D.

A Case of Diverticulosis of the Vermiform Appendix Roentgenographically Demonstrated. John H. Gilmore and Thomas K. Mahan. Am. J. Roentgenol. **56:** 748–750, December 1946.

Diverticulosis of the appendix is seen occasionally by the pathologist but is rarely demonstrated preoperatively. The authors report a case in which appendiceal diverticula were demonstrated on gastro-intestinal examination and later confirmed at surgery.

The patient, a white soldier, aged 25, was admitted to the hospital because of right lower quadrant abdominal pain which had recurred at intervals for two years. There was tenderness in the region of the cecum, most marked over McBurney's point. Rectal examination revealed a small tender mass in the cecal region. No other abnormal symptoms or physical findings were elicited. Routine blood and urine examination showed essentially normal findings. The blood Kahn reaction was negative.

On barium enema examination the colon filled readily, with slight irritability of the ascending colon. A small rounded projection defect extended from the appendix at the junction of middle and distal thirds, and was considered to represent a small diverticulum. Another, more questionable, diverticulum was seen adjacent to it. Examination twenty-four hours following ingestion of an opaque meal permitted incomplete visualization of the appendix. The appendix extended obliquely upward from the cecal tip and was apparently somewhat fixed in this position.

At operation the cecum was found to be fixed. The appendix was retrocecal, retroserosal, and fixed.

Gross examination of the removed appendix showed the serosal surface to be slightly congested but smooth and glistening. Along the medial concave border there were three distinct nodular bulgings, each attached to the appendix along a broad base 6 to 8 mm. in diameter. Incision of the bulgings showed the distal two to have a lumen which communicated freely with the lumen of the appendix. The third showed only a narrow slit-like lumen. On microscopic examination the appendix showed little evidence of inflammatory reaction. The muscular coat of the appendix did not extend completely through the diverticula. A distinct muscularis mucosae was present, however, and was continuous with the muscularis mucosae of the appendix proper.

The patient made an uneventful recovery.

H. H. WRIGHT, M.D.

THE MUSCULOSKELETAL SYSTEM

Fibrous Dysplasia of Bones. Albert W. Mann, Oliver Eitzen, and E. P. McNamee. Am. J. Roentgenol. **56:** 707–711, December 1946.

Fibrous dysplasia of the skeleton has been generally recognized as an entity only since 1937, although it had been known earlier under such names as "osteitis fibrosis cystica congenita" and "precocious puberty and bone brittleness." In addition to bone lesions, there may be such extraskeletal changes as cutaneous pigmentation, somatic precocity in both sexes, and endocrine dysfunction, chiefly in female patients.

While the etiology of the condition is obscure, it is usually attributed to a developmental defect. It is discovered in childhood or early adolescence, a pathological fracture or a limp with pain and deformity of the lower limbs being a frequent complaint. Facial asymmetry, ocular proptosis, and acromegalic changes may occur. Laboratory examinations are frequently negative, but the blood phosphatase may be elevated. One or more bones may be involved. There is a strong tendency for the skeletal involvement to be unilateral. The characteristic bone lesions are scattered areas of rarefaction, areas of increased density and overgrowth of bone being less common. The cortex is thinned, and the medullary space distended. Bowing of the long bones and coxa vara may be present. The rarefied areas in the bones are usually composed of collagenous connective tissue in which there may be small foci of ossification.

The condition is self-limited and becomes quiescent in adults. Treatment consists chiefly in measures to avoid spontaneous fractures by guarding against trauma and severe exercise.

The authors report a case of fibrous dysplasia of bone in a boy, aged 11, who presented only skeletal manifestations of the disease. He showed involvement of the right femur and both forearms, with pathological fractures. The skull was also involved, with marked thickening of the occipital and left parietal bone, associated with sharply defined areas of rarefaction. The left femur showed bowing, with coxa vara, and the left tibia and fibula were affected.

Most of the laboratory findings were within normal limits. However, repeated blood urea determinations varied from 43 to 48 mg. per 100 c.c. and the creatinine ranged from 2.4 to 3.5 mg. per 100 c.c. The blood phosphatase was 5.28 Bodansky units.

A biopsy taken from the left tibia showed abnormal bony tissue, occurring as islands in collagenous connective tissue. Occasional osteoblasts and very few osteoclasts were present. No cartilage was identified.

H. H. WRIGHT, M.D.

Fibrous Dysplasia of Single Bones (Monostotic Fibrous Dysplasia). Hans G. Schlumberger. Mil. Surgeon **99:** 504–527, November 1946.

This paper is based on 69 cases of fibrous dysplasia which were studied at the Army Institute of Pathology. The lesion was confined to a single bone in 67, involved both the right femur and tibia in one, and was polyostotic in another. The ribs were involved in 29 cases, the femur in 9, tibia 8, maxilla 7, calvarium 5, mandible 2, humerus 2, ulna 2, vertebra 1, pelvis 1, fibula 1.

The first sign of the disease was usually a local swelling, particularly if the affected bone was superficial, *e.g.*, the skull, ribs, and tibia. Local tenderness was sometimes associated with the swelling, and occasionally, when one of the long bones was involved, pain of an arthritic character was referred to the nearest joint. In 4 cases the lesion was not suspected until the patient suffered a pathologic fracture. Of the 29 rib lesions, 12 were incidental findings on routine chest films. In contrast to many of the reported cases of polyostotic fibrous dysplasia, none of the cases of the monostotic form showed areas of abnormal skin pigmentation or evidence of endocrine disturbance.

The appearance of monostotic fibrous dysplasia in the roentgenogram offers little that is characteristic. In the long bones the lesions were found principally in the metaphyses, though occasionally they occupied the middle of the shaft. No site of predilection was noted in the ribs. When the skull was affected, the maxilla was most often involved. In the roentgenogram, the area of fibrous dysplasia is radiolucent, sometimes traversed by delicate trabeculae of bone. It is usually central in position and produces thinning and expansion of the cortex, particularly marked in the ribs and fibula and in the bones of the calvarium; at times there is a narrow margin of condensed bone at the periphery. The non-specificity of the roentgenographic appearance in this disease is emphasized by the fact that in not one of these cases was the possibility of fibrous dysplasia entertained by the roentgenologist. The diagnoses offered in order of their frequency were: bone cyst 16, giant-cell tumor 8, osteochondroma 8, tumor 7, enchondroma 4, chondroma, fibroma, ossifying fibroma, osteitis fibrosa cystica, sarcoma, and myeloma 2 each. Osteoma, chondromyxoma, non-osteogenic fibroma, adamantinoma, Ewing's tumor, eosinophilic granuloma of bone, Paget's disease, osteomyelitis, and callus each appeared once.

The pathologic anatomy of fibrous dysplasia is discussed at length. Evidence is presented which suggests that so-called ossifying fibroma and non-osteogenic fibroma of bone are variants of this condition. The monostotic form of fibrous dysplasia is not a congenital anomaly, and etiologically has probably nothing in common with the form of polyostotic fibrous dysplasia found in Albright's syndrome. It may represent a disturbance of the normal reparative process following any of a variety of bone injuries.

Infantile Cortical Hyperostoses. John Caffey. J. Pediat. **29:** 541–599, November 1946.

The author adds 6 new cases of infantile cortical hyperostoses to the series previously reported (Am. J. Roentgenol. **54:** 1, 1945. Abst. in Radiology **46:** 538, 1946). The disorder is a new syndrome of unknown cause and obscure pathogenesis. The components of the condition, common to all the cases investigated, are: (1) deep swellings of the soft tissues and (2) cortical hyperostoses in the neighboring bones. Other important features include fever, hyperirritability, pseudoparalysis, dysphagia, and pleurisy. Laboratory findings are anemia, leukocytosis, increased sedimentation rate, and excessive serum phosphatase.

Hyperostoses have been demonstrated in the mandible and the clavicles most frequently. The calvarium, scapulae, ribs, and the tubular bones of the extremities have also been affected.

Initial symptoms may appear as early as the third week of life, or as late as the twentieth month. Duration of the active manifestations varies from eight weeks to nine months. All patients have recovered. No therapeutic agent has altered the course of the disease.

Among the conditions suggested by the above findings are parotitis, osteomyelitis.and tumor of the mandible, scurvy, poliomyelitis, leukemia, and rheumatoid arthritis or rheumatic fever.

Each of the author's new cases is discussed individually and is accompanied by roentgenograms and a diagram of the skeleton showing the distribution of the involvement. The result is an excellent survey of an interesting syndrome. M. WENDELL DIETZ, M.D.

Osteochondrodystrophia Deformans (Morquio's Disease): Observations at Autopsy in One Case. Nathan H. Einhorn, John Royal Moore, and Leonard G. Rowntree. Am. J. Dis. Child. **72:** 536–544, November 1946.

Osteochondrodystrophia deformans, or Morquio's disease, is characterized by dwarfism, deformities of the bones of the trunk and extremities, and roentgen evidence of absence of centers of ossification, destruction, rarefaction, and proliferation involving all bones, including, directly or indirectly, those of the skull.

The roentgen findings are most helpful in the diagnosis. The epiphyses of long bones are usually irregular, enlarged, flattened, and of varying density, suggesting cellular destruction. The femoral head may be absent, misshapen, or fragmented. The acetabulum and glenoid fossa may be irregular and articulation improper. The diaphyses are thinned and show areas of rarefaction near the ends, and the cortex may be thickened on the side of greatest strain. The small bones of the hands and feet are shortened, with thin cortex, irregularities of epiphyses, and increased trabeculation. The ossification centers for carpals and tarsals are deficient for attained age. The vertebral bodies are flattened and irregular in outline, with rough articular surfaces and frequent wedging. Kyphosis in dorsal and lumbar areas and thickening of intervertebral disks are common. The ribs are wide and flat and the intercostal spaces are narrowed, with anterior protrusion of the sternum of varying degree.

The case reported is of a boy, aged 10, who was observed for several years prior to death. He had developed slowly, had many deformities typical of the disease, and at the age of four had lost control of the sphincters and leg muscles, so that he was confined to bed thereafter. Roentgen studies showed bone changes typical of the disease and, in addition, changes in the upper cervical region and base of the skull similar to those of platybasia.

At autopsy, the posterior cranial fossa was elevated, the upper cervical vertebrae were fused and there was anteroposterior compression of the spinal cord to the level of the fourth cervical vertebra, with microscopic evidence of extensive vacuolation, loss of horn cells, and much glial proliferation. The compression undoubtedly accounted for the neurologic changes observed.

This disease apparently has two phases; first, the structural defects, with postural changes and orthopedic deformities; second, the phase in which the neurologic changes become apparent.

BERNARD S. KALAYJIAN, M.D.

Bone Lesions in Early Syphilis. Report of a Case. Aaron M. Lefkovits and Kenneth R. Cross. Am. J. Clin. Path. **16:** 693–700, November 1946.

A case of early syphilis with widespread involvement of bone in a young white male is presented.

A 22-year-old soldier was treated for malaria in an army hospital in December 1944. The blood Kahn reaction was negative at that time. In January, April, and May 1945, recurrences of malarial fever developed and were treated promptly and successfully with atabrine. In May the patient complained of headaches, a "knot" on his head, pain and swelling over the sternum of three weeks' duration, becoming progressively worse, and a dull aching pain in the region of the right scapula. Examination showed localized swollen

areas over the right fronto-parietal, the parietal, and temporoparietal regions of the skull, and over the right costosternal junction at the level of the second rib. These swollen areas varied in size from one-half inch to one inch in diameter and were tender on pressure. X-ray examination of the skull on May 26 showed a small tumor in the soft tissue of the scalp on the right side just anterior to the coronal suture, about 4 cm. lateral to the sagittal suture. There was slight erosion of the outer table of the skull at the site of the tumor. The sedimentation rate was 44 mm. in one hour. The complaints referable to the skull and sternum continued and the pain in the right scapula became worse. Films taken on June 1 showed an increase in the size of the lesions noted on May 26. There was no bony involvement of the sternum and right scapula. On June 20 the blood Kahn and Kolmer reactions were positive. On June 30, x-ray examination showed a slight increase in the size of the areas of erosion in both the right and left frontal and the right parietal bones. One of these areas appeared to penetrate the inner table of the skull. On July 23, several irregular areas of alopecia over the occipital and parietal regions were observed. X-ray examination of the bones of the left upper extremity, both lower extremities, and pelvis showed no abnormalities.

On July 6 the largest skull lesion was curetted. Histologic examination showed granulomatous tissue with some focal distribution of inflammatory infiltration. Actual caseation was absent, but slight degeneration associated with active fibroplasia and osteogenesis was evident. There was only moderate endothelial hyperplasia. These changes represent one phase of syphilitic osteomyelitis. A lymph node removed from the left inguinal region showed multiple small granulomata and generalized lymphoid and reticuloendothelial hyperplasia commonly seen during the secondary stage of syphilis.

At first the positive blood reaction was thought to be a false positive because of the coexisting malarial infection. The true nature of the disease was recognized only after histologic sections of bone and lymph node were examined. The diagnosis was confirmed by quantitative serologic studies at the Army Medical Center. Although the patient had no demonstrable primary luetic lesion, it is believed that he acquired syphilis during a furlough in March. The tender swollen areas on the skull were first noticed approximately four to six weeks after sexual exposure, or well within the period of secondary stage. The paroxysms of chills and fever due to the recurrent vivax malarial fever had no effect upon the invasive ability of the spirochetes. The patient made an excellent response to penicillin.

Some Observations Concerning Ewing's Tumor Seen in an Army General Hospital. Gilbert W. Heublein, Sylvan E. Moolten, and Joseph C. Bell. Am. J. Roentgenol. **56:** 688–706, December 1946.

The clinical features, histopathology, diagnosis, and treatment of Ewing's tumor are discussed, and 7 cases illustrating various aspects of the disease are presented.

Of 30,442 admissions to the Percy Jones General Hospital, 55 were for bone tumors, 24 of which were malignant, 10 representing Ewing's tumor. The incidence of bone tumors was unusually high because this hospital was both an amputation and deep roentgen therapy center. Reports from large civilian hospitals show a much lower ratio of bone tumors to admissions.

Ewing's tumor occurs most often in young persons, between the ages of five and fifteen, and 3 out of 4 cases occur in males. The "pipe" bones are the most frequent sites, especially the tibia, fibula, humerus, ulna, and femur. The clavicles, tarsal bones, ribs, vertebrae, mandible, skull, shoulder girdle, and pelvis are also occasionally involved. The most frequent clinical findings are (1) history of trauma, (2) intermittent symptoms of pain and fever, (3) a mistaken diagnosis of chronic osteomyelitis in the case of long bones or of tuberculosis in the presence of vertebral involvement. Joint involvement is rarely seen. Considerable local hyperemia may be present, adding to the difficulty in distinguishing this condition from osteomyelitis.

The histogenesis of Ewing's tumor is a subject upon which there is much disagreement. Basically the tumor consists of solid cords of rounded cells separated by fibrous bands. Delicate reticulin fibers may exist between individual tumor cells or may be absent. The nuclei are rounded, and the cell outline is indistinct. There is a marked uniformity in the appearance of the cells. One of the most characteristic features is the absence of intercellular substance. The cells are two to four times the size of a small lymphocyte. Some maintain that it is impossible to separate reticulum-cell sarcoma and Ewing's tumor and that the two are variants of the same condition. The cell of origin has been considered by some to be the undifferentiated mesenchymal cell which in postnatal life is found about small blood vessels and capillaries. Differentiation of this cell along various lines, according to this opinion, could produce fibrosarcoma, osteogenic sarcoma, and lymphoblastoma. Because of the constant association of this tumor with a bone locale, it seems necessary to relate the tumor in some manner to osteogenic mesenchyme. The authors consider the tumor an embryonal osteoblastoma, non-osteogenic.

The clinical findings, roentgenographic study, and histopathologic examinations are all important in making the diagnosis of Ewing's tumor. The roentgenogram will ordinarily indicate whether the tumor is intrinsic or extrinsic in relation to the shaft, whether it is benign or malignant, and the extent of involvement. In some instances the tumor type may be accurately determined. Occasionally the roentgen findings may be more diagnostic than the pathologic report based on insufficient biopsy material. Osteomyelitis is the condition most likely to be confused with Ewing's tumor. Any obscure lytic changes in bone or minimal periosteal proliferation should be followed by serial roentgenography and early biopsy. Ewing's tumor occurring in the sacrum is particularly difficult for differential diagnosis. One should remember that in Ewing's tumor there may be spontaneous decrease in the size of the lesion. The presence of intercurrent disease, such as syphilis, may be a confusing factor.

Where the diagnosis of Ewing's tumor is suspected but cannot be substantiated by biopsy, the therapeutic test is valuable. Small doses of 100 to 150 r will often cause rapid regression of the tumor and relief of pain after only a few treatments. With other osteogenic tumors relief of pain does not ordinarily occur with moderate amounts of roentgen therapy, or the analgesic effect is delayed for a matter of two weeks or more.

Treatment is primarily surgical, and the use of deep roentgen therapy alone is not warranted except where the lesion is inoperable. H. H. WRIGHT, M.D.

Primary Liposarcoma of Bone. Report of a Case. Herman B. Williford and Thomas J. Fatherree. U. S. Nav. M. Bull. **46**: 1750–1755, November 1946.

A diffuse bone tumor involving the pelvis, with metastases to regional lymph nodes and the chest, is recorded. The patient, a 31-year-old seaman, was admitted to the hospital complaining of pain and stiffness in the lumbosacral area, first noticed several weeks previously, when lifting an aircraft propeller. Subsequently, coughing or straining produced a momentary sharp pain in the lower lumbar area. About four days prior to admission a dull generalized lumbosacral pain developed following the onset of a cold. The patient complained, also, of weakness of a month's duration and a loss of about 15 pounds over the past several months.

Examination of the blood showed an anemia (hemoglobin less than 7.5 gm. per cent; red blood cells 1,600,000) which appeared to be of a hypochromic, microcytic type. Roentgenograms of the dorsal and lumbar spine, the skull, and both thighs and legs were within normal limits. An intravenous pyelogram was likewise essentially normal. Prominent markings were present throughout the entire right lung, but there was no definite evidence of metastasis or parenchymal infiltration. Stereoscopic studies of the pelvis showed a diffuse, irregularly distributed, predominantly osteolytic lesion involving the sacrum, the upper two-thirds of the ilium bilaterally and, to a lesser extent, both pubic bones. Irregular areas of osteoblastic activity were associated with the bone destruction. The osteolytic and osteoblastic processes combined to give the bone a mottled appearance. These findings were interpreted as metastases of undetermined origin.

The patient was treated symptomatically, and attempts were made to combat the anemia. In one month the red blood cells numbered 3,050,000 and the hemoglobin 9.5 gm. per cent. A chest film now revealed a moderately large convex shadow at the left hilum, which was interpreted as a metastasis to the hilar nodes. Throughout the medial two-thirds of the right lung field was a very fine parenchymal infiltration, with peribronchial distribution. In the lower half of the lung there was some confluence of these linear areas of infiltration, with the formation of small areas of consolidation. No bony metastasis was noted in the thorax.

During the next month the patient slowly lost ground, and death followed a cerebrovascular accident two months after admission. An autopsy was performed. Microscopic examination revealed neoplastic tissue in the bone marrow, lymph nodes, lungs, and right kidney. Pathologically the lesion was considered to represent primary liposarcoma of bone.

The x-ray findings in the bone in this case presented no particular features which might not be produced by a predominantly osteolytic metastatic carcinoma. The lesion was so interpreted initially, and a review of the films following postmortem examination brought out no features which would lead to a different interpretation should a similar situation be encountered. The chest findings also presented no peculiarities which would give a clue as to the nature of the underlying metastatic tumor.

Skeletal Lymphosarcomatosis with Secondary Hyperparathyroidism. A. van der Sar and P. H. Hartz. Am. J. Clin. Path. **16**: 701–713, November 1946.

A case of hyperparathyroidism secondary to skeletal lymphosarcomatosis in a 55-year-old Negro male is reported. The patient was admitted to the hospital with a diagnosis of rheumatoid arthritis or syphilis. He complained of pain in all extremities and of dull headache for six months. He had been bedridden for two months. His joints were painful but not swollen, and walking was difficult. The skull appeared to be getting softer and smaller in circumference. In the last eight months all of the teeth had fallen out. There were no urinary symptoms.

The patient was emaciated, weighing only 92 pounds. The head was very tender to palpation; much of the calvarium had disappeared, and only a soft mass could be felt. The cervical lymph nodes were not palpable, and the thyroid was not enlarged. The chest was painful to palpation. The fingertips of both hands were slightly enlarged and the nails had the appearance of a parrot's beak. Wassermann and Kahn tests were negative. Serial chemical examination showed a hypercalcemia. The phosphorus content of the blood serum was low. Roentgenograms showed severe decalcification of the whole skeleton, the lesions closely resembling those of osteitis fibrosa and metastatic tumor. Except for small areas in the tibias and heads of the fibulas, the distal ends of the extremities were atrophied. Urinalysis during a constant low calcium diet showed a high excretion of calcium and inorganic phosphorus. A tentative diagnosis of hyperparathyroidism was made on the basis of chemical examinations. Biopsy of a rib supported this diagnosis.

A quick deterioration in the patient's condition, with an irregular fever and uremic symptoms, made an exploratory operation impossible for some time. When it was finally undertaken, the parathyroids were found to be slightly enlarged and of normal number. No adenoma could be detected. One left and two right glands were removed. The patient died in uremia.

Necropsy revealed diffuse lymphoid tissue consisting of small and medium-sized lymphocytes in the tonsils, lymph nodes, calvarium, dura, and periosteum. The authors believe, therefore, that a diagnosis of lymphosarcomatosis with cranial metastasis is warranted. There was an extensive absorption of bone by osteoclasts and replacement of normal marrow by connective tissue rich in collagen and containing lymphocytes and multinucleated giant cells. These findings, together with the results of the biochemical and roentgen examinations, are typical of osteitis fibrosa. The presence of lymphocytic infiltrates in the fibrous marrow may be considered as a chronic inflammatory reaction or as a beginning infiltration with neoplastic cells; the authors favor the first view. The calcification in the lungs and kidneys found at autopsy must be regarded as a sequel of the osteitis fibrosa.

The parathyroid glands were only slightly enlarged and consisted almost exclusively of principal cells. On the basis of these findings, the histologic findings on biopsy of the rib, the hypercalcemia, the low phosphorus content of the blood, and the high excretion of calcium and phosphorus in the urine, a hyperparathyroidism is believed to have existed. This was probably secondary to a disturbance of the calcium metabolism caused by metastatic skeletal lymphosarcomatosis.

Pyogenic Osteomyelitis of the Spine. Peter Martin. Brit. M. J. **2**: 688–691, Nov. 9, 1946.

Osteomyelitis of the spine, forming part of a generalized bacteremia, has usually been a fulminating infec-

tion, fatal in a high percentage of cases. Antemortem diagnosis has not often been made. When, however, the disease is localized, the mortality may be as low as 25 per cent. Martin believes that many so-called cases of spinal tuberculosis which heal rapidly with early fusion may in reality be pyogenic osteomyelitis, and their inclusion would reduce the mortality still further.

Pyogenic osteomyelitis of the spine is more common in males (3 to 1) and the usual age of onset is in the third decade in contrast to the earlier occurrence of osteomyelitis elsewhere. The most common infecting agent is *Staphylococcus aureus*, while *Staphylococcus albus* and *Streptococcus* are more rarely responsible. The lumbar region is most frequently involved. The bodies of the vertebrae are generally affected as a metastatic phenomenon, the primary focus being in a boil, tooth infection, septic wound, or other suppurative process.

Pathologically an ulcerating lesion showing a tendency to spread to adjacent segments is produced. The disk cartilage is rapidly destroyed early in the process, and the infection then attacks the next vertebral body. This is in contrast to tuberculosis, in which the disk is not so readily destroyed and spread of the infection to adjacent vertebrae is under the anterior spinal ligament rather than through the disk. Abscesses often occur and may point along fascial planes, producing retropharyngeal, mediastinal, psoas, perinephritic, or pelvorectal abscesses depending on the portion of the spine involved. Sinus formation is not uncommon. Abscess may be present with minimal bone involvement. Epidural abscess with compression of the cord or meningitis occurs infrequently but carries a high mortality.

The onset is often acute with local signs obscured by the intensity of the toxemia. Spontaneous lumbar pain, diffuse at first and later localized, is often severe enough to confine the patient to bed. It is accompanied by muscular spasm and signs of toxemia.

Radiologically little may be found in the fulminating cases. In the subacute infections, as the disease attacks the vertebral body, it may be two to three months before x-ray changes are demonstrable. Narrowing of the intervertebral space with moth-eaten irregularity of the adjacent bony surfaces is the first change. Increased density of the affected vertebral body, with areas of mottled rarefaction, is common. Subperiosteal new bone is formed at the edges of the contiguous vertebrae, leading to a beaking which continues to increase in size and eventually fuses, producing bony ankylosis. This may occur in seven months or more.

The differentiation from tuberculosis may be difficult, but the acute onset, the early cartilage destruction, the signs of toxemia, and the absence of collapse of the vertebral body are usually diagnostic. Five illustrative case reports are presented. The treatment is bed rest with support, a plaster jacket, general measures including the use of penicillin and other medication, and surgical drainage of abscesses when formed.

BERNARD S. KALAYJIAN, M.D.

Myelography in Lumbar Intervertebral Disk Lesions: A Correlation with Operative Findings. A. Charles Begg, Murray A. Falconer, and Murray McGeorge. Brit. J. Surg. **34:** 141–157, October 1946.

On the basis of operative and myelographic experience the authors divide disk lesions into four separate groups, as follows: (1) a constant, localized projection, of nuclear substance still covered by the smooth glistening annulus fibrosus, thinned but intact, the commonest type; (2) an intermittent prolapse, occurring only when the intervertebral disk is subjected to certain strains; (3) extrusions, due to rupture of the annulus fibrosus and escape of nuclear material into the spinal canal; (4) scarred disks, in which, over a period of years, the opposing surfaces of the vertebral bodies become sclerotic, the disk space is diminished in width, and the theca and extrathecal nerve root become adherent to the back of the disk without an actual projection.

Myelography, employing either pantopaque or lipiodol, was carried out in 95 of 100 consecutive cases of sciatica and low back pain. The method of examination is described in detail and differs very little from that employed by most authorities. With hyperextension of the spine it was found possible to demonstrate lesions which the usual technic failed to disclose. Lipiodol was aspirated at operation after the theca had been opened. Pantopaque was often left *in situ* and no harmful effects were noticed. This permitted re-examination at intervals after the initial myelogram. Follow-up radiological studies have shown that pantopaque is slowly absorbed, approximately two-thirds of its volume in a year.

The anatomical considerations in relation to myelography are discussed in detail, with excellent illustrations. The first sacral nerve roots emerge from the theca at or just below the 5th lumbar disk. The 5th lumbar nerve roots emerge at or just below the 4th lumbar disk, while nerve roots higher up all emerge below the disk cephalic to their numerically corresponding vertebra. Consequently disk protrusions situated posterolaterally at the 4th and 5th lumbar spaces readily compress the 5th lumbar and 1st sacral nerves, respectively, while similar protrusions at higher levels usually do not involve an extrathecal nerve root.

The normal myelogram is well described under two headings, the thecal column and the root pouches. The optimum amount of medium is 3 c.c.; this amount, when collected along the anterior wall of the lumbar theca, forms a pool which is usually sufficient to straddle one disk space at a time, but not two. The width of the thecal column may vary from 30 to 80 per cent of the interpedicular distance. The filling of the root pouches will depend on time, gravity, and the posture of the patient.

Disk prolapses are divided into central and lateral groups according to their location in the coronal plane. Central prolapses lie anterior to the theca, while lateral protrusions lie between them and the intervertebral foramen. If a central prolapse is large enough, a complete block will result, but this is uncommon. With medium-sized prolapse the usual finding is an hour-glass constriction of the thecal column. Prone lateral views of these hour-glass constrictions have invariably disclosed an anterior invagination of the thecal column confirmed by operation. The authors do not believe that hypertrophy of the ligamentum flavum produces this deformity. A less common appearance with a medium-sized prolapse is a rounded zone of radiolucence lying within the thecal column and causing no deformity of its margins in the anteroposterior view. The anterior invagination can be detected only in the prone lateral projection. When a prolapse occurs in relation to an extrathecal nerve root, there will be a defect in the lateral border of the thecal column, while the corresponding root pouch usually fails to fill. Lesions situ-

ated anterior or slightly anterolateral to the nerve root cause a defect in the filling of the root pouch without disturbing the thecal column. When the prolapse is situated further laterally the myelogram may show a characteristic change or it may remain normal.

The question of intermittent prolapses is discussed in detail. These are the "concealed" disks described by Dandy (J. A. M. A. **117:** 821, Sept. 6, 1941). The authors employ extension of the spine to demonstrate the prolapse by myelography and also at operation.

Extrusions may displace root pouches and they may cause defects in the thecal column at a distance from the disk space.

Scarred disks can be identified by plain films in conjunction with myelography. The indentation in the myelogram coincides with the bony spurs and is not caused by soft-tissue protrusion. Many scarred disks of this type are asymptomatic.

The indirect effects of disk prolapse are swollen intrathecal nerve-roots and arachnoiditis. The latter is identified by a serrated edge produced by seepage of medium between the neighboring roots of the cauda equina matted together with adhesions. Hypertrophy of the ligamentum flavum has not been found at operation, and the authors believe that the myelographic appearance adduced by other authors as evidence of this condition is to be explained by disk lesions alone.

Artefacts may give rise to misleading appearances and render the myelogram worthless. These may be produced by the medium leaking into the subdural space, into the extradural tissues, and along the epidural spaces. To prevent these conditions, lumbar puncture should be performed with the patient lying horizontal and the injection should not be made within several days of a previous spinal puncture.

In 86 cases of this series satisfactory myelograms were obtained, and of these 76 were interpreted as pathological while 10 (12 per cent) were considered normal. In all except 1 case one or more disk lesions were subsequently established at operation. In each of the 10 cases with negative myelograms a disk lesion was present at operation. In 74 cases the presence and level of a disk protrusion were indicated with almost complete accuracy. In this series a third of the prolapses were centrally placed, while two-thirds were laterally placed.

A large number of excellent reproductions of myelograms illustrate the various types of disk lesions found by the authors. MAX CLIMAN, M.D.

Congenital Bipartite Carpal Navicular. Thomas F. Rose. Australian & New Zealand J. Surg. **16:** 149–151, October, 1946.

Rose cites the case of a 37-year-old soldier who sustained an injury to the right wrist and subsequent x-rays were interpreted as an ununited fracture of the navicular. Studies of the left wrist disclosed similar findings, despite a negative history of trauma. Because the physical findings and roentgenograms were not indicative of a carpal fracture, a diagnosis of a tear of the volar radio-carpal ligament was made, associated with bilateral bipartite navicular carpals. The patient's recovery was complete, and films taken at a later period disclosed an unchanged appearance of the bipartite naviculars.

A true bipartite navicular is divided across the waist into more or less equal portions. There is a joint space between the fragments which communicates with the carpal joint system, but is separated from the radiocarpal joint by a ligament uniting the proximal edges. The dividing line extends obliquely from the outer end of the articulating surface of the radius to about the middle of the concave surface of the head of the capitate. This condition is commonly bilateral, though unilateral cases have been reported.

The author stresses points in differential diagnosis. The prevailing criteria, lack of trauma, lack of disability, and a bilateral lesion are considered insufficient evidence on which to base a diagnosis of bipartite navicular. Despite slight and perhaps forgotten trauma and minimal disability, x-ray studies may demonstrate an ununited fracture of the navicular.

The final diagnosis is therefore solely dependent upon the radiologic findings. The bone texture of each fragment of a bipartite navicular is normal and of equal density. The apposing edges of the fragments are smooth and thin, and there is no evidence of osteoporosis or osteosclerosis. Should there be any change in bone texture, such as irregularity or increased density in the line of demarcation, then the separation must be regarded as a fracture, even though the condition is bilateral and the patient cannot recall injury.

LOUIS BERNSTEIN, M.D.

Para-Articular Calcification in the Lower Extremities of Paraplegic Patients. William C. Ward. Am. J. Roentgenol. **56:** 712–715, December 1946.

Calcification about the joints and in the soft tissues of the lower extremities of paraplegic patients has been reported infrequently. Previous reports are mainly from the European literature and indicate that the condition had been observed in veterans of World War I who had sustained spinal cord injuries.

The author observed 88 patients with spinal cord and cauda equina injuries of varying severity. Only 33 of these were seen for any considerable period. Para-articular and soft-tissue calcification in the lower extremities was observed in 4 of these patients, but as only those patients with swelling or stiffness of the joints were completely studied by roentgenograms, the actual incidence is unknown. Three of the patients had only a minor degree of calcification about the knee joints. The fourth had extensive calcification about the knees and in the soft tissues of the lower thighs.

This last patient, a 26-year-old soldier, sustained a shell fragment wound of the spine at the level of the 10th thoracic vertebra. A lumbar puncture on the following day revealed complete block of spinal fluid. During the ensuing week massive edema of both lower extremities developed and within a month large decubitus ulcerations were present over both hips and the sacrum. Roentgenograms of the lower extremities made approximately eleven weeks following the injury showed extensive calcification in the soft tissues about both knee joints. With supportive therapy the edema of the legs was reduced, and the decubitus ulcers improved. Fine granular deposits of calcium were noted in the soft tissues of the right hip region approximately six months following injury. At eleven months there was some fragmentation of the articulating surface of the head of the femur, with marked para-articular calcification.

It appears that calcification about the joints and in the soft tissues usually begins during the first year after spinal cord injury, if it is to develop, except in those cases that have late associated fractures. The cause of

the calcification is not known. Multiple minor traumatisms have been considered a predisposing factor. Edema of the extremities is a fairly frequent finding shortly after spinal cord injury, due to immobilization, vasomotor relaxation, nutritional hypoproteinemia, and other factors. Patients who have been observed to have even minor degrees of soft-tissue and paraarticular calcification have had massive edema of the lower extremities following the spinal cord injury. There is rapid demineralization of the bones of the lower extremities with associated hypercalcinuria. The calcification about areas of fractures that have occurred late after spinal cord injury is related to trauma and hemorrhage into the soft tissue.

Extensive calcification about the knee or hip joints may interfere with the rehabilitation of the paraplegic patient. No treatment has been recommended for the condition. Prevention of fracture which might result from too vigorous efforts at rehabilitation is emphasized. H. H. WRIGHT, M.D.

Avulsion Fracture of the Eminentia Intercondylica in the Knee Joint. F Jakob. Schweiz. med. Wchnschr. **76:** 1230–1231, Nov. 30, 1946.

Avulsion fracture of the tibial spine is a result of pull on the cruciate ligaments. The fracture may be found in association with fracture of the tibial condyle. The injury is commonly sustained during a ski run. The external mechanism is either forcible external rotation with abduction, or else hyperextension. The diagnosis is seldom made clinically because of gross distortion of the joint from the accompanying hemarthrosis; there is no sign pathognomonic of ligament injury, and a conclusive diagnosis of fracture can be made only by roentgen study. The fracture may vary from the faintest fissure to gross avulsion of the top of the tibial spine. In severe cases there is often a tendency to lateral dislocation of the tibia, usually of slight degree.

Therapy should be conservative, generally plaster immobilization; operation is reserved for cases of severe dislocation or displacement of the fragment with symptoms of joint mouse, and in these removal rather than replacement of the fragment is recommended. Results are usually good; occasionally a slight limitation of flexion remains. LEWIS G. JACOBS, M.D.

GYNECOLOGY AND OBSTETRICS

Pelvigraphy. D. Jefferiss and Eric Samuel. Brit. J. Radiol. **19:** 462–468, November 1946.

Pelvigraphy was first described by Kjellberg in 1942. The present paper presents the results in 21 patients. A water-soluble opaque medium is injected by a technic similar to that used in uterography, but in addition to filling the uterus the solution is allowed to flow through the tubes into the pelvis. The authors use 20 to 30 c.c. of any preparation suitable for intravenous pyelography, after diluting it with 10 to 15 c.c. of 0.5 per cent novocaine. The injection is made under fluoroscopic control.

An anteroposterior film is made as soon as the uterine cavity and the tubes are filled. The solution is then allowed to flow through the tubes into the pelvic cavity and three more films are made, an anteroposterior and a right and left lateral, with the patient on her side and the beam horizontal. Since the shadow of the medium is not very dense, careful radiographic technic is required.

No complications were encountered. The catheter could not be passed into the cervical canal in 3 cases. Pain was severe in one patient and slight in two.

The appearance of the uterine cavity and tubes is the same as with opaque oils. In the pelvis, the dye accumulates in Douglas' pouch and spreads out, outlining the solid structures in the pelvis and also coating the bowel. The latter sometimes produces confusing shadows, but can usually be identified.

In hydrosalpinx the dye usually enters the dilated tube and mixes with the contained fluid, producing an oval opacity with a moderately clear outline, situated, along the line of the fallopian tube, often showing a fluid level or stratification. Cystic ovarian tumors can usually be readily recognized. General thickening of the uterine wall can be seen, and pedunculated fibroids on the peritoneal surface can usually be diagnosed. Tumors of the broad ligaments may be visualized. Occasionally inflammatory adhesions may be seen, but in inflammatory disease the tubes are frequently occluded. SYDNEY J. HAWLEY, M.D.

THE GENITO-URINARY SYSTEM

Arteriography in Renal Diagnosis. Preliminary Report and Critical Evaluation. Frederick B. Wagner, Jr. J. Urol. **56:** 625–635, December 1946.

The author's object is to stimulate further interest in arteriography as an aid to renal diagnosis by description of a simplified technic, critical evaluation of the procedure, and presentation of three cases.

After preliminary anesthesia, the twelfth rib on the left side is palpated. With a short stout needle the skin is punctured just below this rib, four fingers' breadth from the spinous processes. A 15-cm. needle is then introduced through the puncture hole and directed anteriorly, medially, and cephalically toward the body of the twelfth thoracic vertebra. When bone is encountered, the needle is withdrawn about 2 cm. and the point directed more laterally so as to just pass by the vertebral body. The stilet is then removed and the needle cautiously advanced to within a few centimeters of its hilt. The aortic wall is encountered as a resistance through which the needle snaps, imparting to the operator a sensation similar to that experienced in penetrating the dura mater during a spinal tap. Almost immediately bright red blood emerges from the needle as a pulsating drip which descends as a rivulet on the shaft.

The needle is then connected to the rubber tubing and syringe which have been previously filled with sterile salt solution. Barbotage is carried out to note the ease of flow in both directions. A trial injection of 12 c.c. of saline solution within six seconds is made in order to estimate the force required. The stopcock is then closed, the syringe disconnected and filled with approximately 12 c.c. of 80 per cent sodium iodide solution. The syringe is again connected, the stopcock opened, and blood withdrawn as a final proof that the needle is well within the lumen. The signal "ready" is given to the x-ray technician, the solution is injected at the rate of 2 c.c. per second, and the signal "shoot" given as the final cubic centimeter or two leave the syringe. Immediately following exposure of the roentgen film the needle is withdrawn.

The author indicates that this technic is best suited for visualization of branches of the celiac axis and superior mesenteric artery. Visualization of the

renal artery and its branches appears to be better if the needle is inserted one vertebral level lower.

Before undertaking abdominal arteriography one should be fully acquainted with the difficulties and potential dangers. In the first place, the patient is exposed to the hazards of anesthesia, acute iodism, extravasation of radiopaque medium, and hematoma following puncture. Secondly, the operator must acquire a thorough knowledge of the relational anatomy involved in the procedure. Aortic puncture should first be practised in the dissecting or postmortem room in order to acquire experience and confidence. Thirdly, the actual technic, though relatively simple, is exacting and demands perfect co-ordination of the team, for the slightest error may yield an unsatisfactory film. Finally, even an excellent arteriogram in some instances may be difficult to interpret accurately because of lack of experience.

The author cites the literature and his own experience (23 aortographies) to indicate that the risk of abdominal arteriography seems no greater than that of arteriography of peripheral vessels. It is his opinion that this type of study is of value as an occasional diagnostic adjunct in carefully selected instances. From the standpoint of renal diagnosis the study may be indicated when all other studies have been exhausted and further information is desired regarding: (1) hypertension in which surgical treatment is contemplated; (2) aberrant renal vessels as a possible cause of hydronephrosis; (3) renal or adrenal tumors; (4) possible renal aneurysm; (5) suspected aortic obstruction near the renal arteries.

The three cases described include one of hypertension, one of possible renal aneurysm, and one of an unusual renal tumor. MARLYN W. MILLER, M.D.

Pelvic Single Kidney: Report of a Case. Howard B. Mays. J. Urol. **56:** 619–624, December 1946.

Inclusive of the author's case, there are only 41 reported cases in the literature of pelvic single kidney or congenital solitary pelvic renal ectopia.

Urinary symptomatology in the majority of cases is usually insignificant or absent. An associated anomaly of male and female genitalia was found in 20 of the 41 cases. The condition should be considered as a possible diagnosis, and further urologic study should be made, in the presence of an unexplained pelvic mass extrinsic to the intestine as suggested in a gastro-intestinal roentgenographic study, or causing extrinsic pressure on the bladder during cystoscopy or on the bowel during sigmoidoscopy. Bimanual palpation of pelvic masses in male and female may also prove to be of considerable aid in diagnosis.

The author's patient was a 29-year-old white male, who had led a normal active life and at the time of admission to a military hospital had been on active duty in the China-India-Burma theater for two years and seven months. He was admitted to the hospital complaining of pain in the hypogastrium, fever, and nausea of two days' duration. He had had similar episodes at irregular intervals for four years prior to admission. He had recently been treated for tertian malaria. Examination revealed definite tenderness in the lower abdomen. In the hypogastrium a rounded, smooth, firm mass was palpable extending above the symphysis and to the right of the mid-line. The mass was defined, as well, on bimanual examination. The genitalia were normal, as were the rectum and prostate. Urinalyses were negative. Roentgen study of the gastro-intestinal tract showed that the mass was not directly associated with the large or small intestine, though an appendiceal abscess was considered a possibility. The survey abdominal roentgenogram showed no distinct nephric outlines and the psoas muscles were indistinct. Exploratory laparotomy revealed a large ectopic right kidney, with a short renal artery coming off the iliac artery. There was no evidence of another kidney on either side.

Urologic study subsequently was undertaken. Cystoscopy revealed a total absence, with no discernible vestige, of the left half of the trigone. There was no evidence of a left ureteral orifice. The right portion of the trigone was normal and the right ureteral orifice was not unusual. The fundus was asymmetrical. Renal function was considered normal and urine cultures were negative. Retrograde pyelography demonstrated the kidney pelvis over the lower sacrum and slightly to the right of the mid-line. The pelvis was small and the ureter short and tortuous. Excretory urograms demonstrated apparently normal function, absence of obstruction, and emptying time well within normal limits.

The subjective symptoms suggested recurring obstruction to the flow of urine. However, the objective evidence of interference with urinary output was entirely lacking and surgery was deemed to be contraindicated. DAVID S. MALEN, M.D.

THE BLOOD VESSELS

A Case of Congenital Multiple Arteriovenous Fistulae of the Hand. J. A. White. Brit. J. Surg. **34:** 209–211, October 1946.

A girl aged 12 had a purplish discoloration of the right hand, present since birth. Increase in the size of the hand and deformity had been noticed for the past two or three years. Examination revealed a large irregular port-wine stain on both palmar and dorsal surfaces. The whole hand and forearm were covered with dilated veins. The four fingers showed gigantism and deformities. A thrill was palpable in the palm, and with the stethoscope a continuous-cycle bruit with systolic accentuation could be heard over most of the hand but was maximum on the palmar surface at the base of the first finger. No murmur could be heard above the wrist when a tourniquet had been applied at this level, thus proving the arteriovenous communications to be at or below the wrist. The blood pressure in the affected upper arm was 125 systolic and 40 diastolic while in the normal arm it was 95 systolic and 60 diastolic.

X-ray examination of the right hand revealed hyperostosis of the 2d, 3d, 4th, and 5th metacarpals, deformity of the radial and ulnar epiphyseal regions, and a patchy sclerosis of the semilunar bone as in Kienböck's disease. The shafts of the 2d, 3d, and 4th phalanges showed irregular trabeculations and increased bone striations, as seen in hemangioma. An arteriogram showed extensive arterial filling of the palmar arch with accumulation of medium between the heads of the 2d and 3d metacarpals. There was no filling of the thumb area. These findings suggested multiple fistulae and small aneurysmal sacs in the region of the 2d and 3d metacarpophalangeal joints.

Injections of sclerosing fluid into regional veins had no effect. Four attempts at surgical extirpation gave no

improvement and the patient was discharged. A severe hemorrhage later necessitated amputation through the forearm at another hospital. MAX CLIMAN, M.D.

TECHNIC

Persistence of Fluoroscopic Screens. Willard W. Van Allen. Pub. Health Rep. **61:** 1583–1588, Nov. 1, 1946.

The luminescence produced in phosphors by exciting visible light, ultraviolet or roentgen rays has long been recognized as of two distinct types: (*a*) fluorescence during excitation, and (*b*) fluorescence after the exciting radiation has been cut off. Phosphorescent emission is of longer wave length than fluorescent emission, and phosphorescence lasts for an appreciable time after termination of the exciting radiation, whereas fluorescence occurs only during excitation. While these mechanisms have been described previously, the exact part they play in diagnostic radiology has not been brought before the radiologist critically. The phenomenon of "lag" or "persistence" has been noted, but the qualities of different screens has not been brought out as clearly as in the present paper. There is also another concept, which is relatively new and usually not appreciated—in some screens the phosphorescence "builds up" during successive exposures until it reaches values many times greater than that after a single exposure. With the advent of the photoelectric timer, this persistent phosphorescence causes successive exposures to be prematurely terminated, with the result that films are underexposed as well as lacking contrast.

The U. S. Public Health Service, through Dr. Van Allen, carefully investigated four screens, Patterson Types B and D and the U. S. Radium Corporation's 666D and 574A. The screens that have little "lag" and do not "build up" under multiple exposures are, of course, best. There is, however, considerable difference in the resolving power of the screens. The Patterson Type B shows a slight "lag" advantage; in resolving power, the U. S. Radium Corp. 666D screen has considerable advantage. [For further observations on screen characteristics, see Morgan: Radiology **49:** 90, 1947.—ED.] SYDNEY F. THOMAS, M.D.

RADIOTHERAPY

Analysis of 402 Cases of Carcinoma of the Breast. Evelyn Siris and Leonard Dobson. California Med. **65:** 201–206, November 1946.

In view of the differences of opinion as to the proper treatment in operable breast tumors with axillary involvement, the authors undertook an analysis of 402 cases of breast cancer treated from 1926 to 1945. The classification was in general that of Steinthal. Of the 402 cases, 90 were in Stage I, 109 in Stage II, 83 in Stage III, 27 in Stage IV, and 93 in Stage V (recurrent).

Radical mastectomies were done in 202 instances. Major complications were partial sloughs of skin flaps in 34 cases and edema of the arm (never severe enough to be disabling) in 26 cases. In 149 of these cases followed for five years or more after operation, regional recurrences were recorded as follows: in the skin, 24 cases; in the axilla, 14 cases; in the supraclavicular nodes, 16 cases. In 375 cases, including those treated by radical mastectomy alone and with preoperative and postoperative irradiation, as well as cases of recurrent cancer following operation elsewhere, the predominant sites of metastasis were the lungs, pelvis, and spine.

Summarizing their results, under a policy of operating upon all Stage I and Stage II cases and giving postoperative irradiation when axillary metastases were present, the authors found that 64 per cent of 42 Stage I cases (1926–41) were arrested for five years. The recurrences, early and late, were nearly half in the skin and nearly a tenth in the axilla, which suggests that the criteria for staging were not followed rigidly enough and/or also that microscopic examination of the axillary nodes was not searching enough. Thirty-five Stage II cases were treated by radical mastectomy alone (1926–41). A third of these recurred within five years, another third were arrested, and the remainder went on to late recurrence. Among 21 Stage II and III cases treated before 1941 with preoperative irradiation, there were only 7 five-year arrests (including 3 late simple mastectomies in cases initially well controlled by irradiation). Seventy-five Stage III cases yielded only 2 five-year arrests (x-ray irradiation), but many of the patients lived for several years with disease but in fair comfort.

On the basis of their study the authors have discontinued the use of preoperative and postoperative irradiation in operable breast cancer, but they continue to be "enthusiastic for the use of x-ray in holding incurable breast cancer in check and relieving the patient of the miseries of the disease for months or years." The beneficent effect of x-rays in the treatment of skeletal metastases is considered outstanding.
MAURICE D. SACHS, M.D.

Radiation Treatment of Localized Malignant Lymphoma. George W. Holmes and Milford D. Schulz. New England J. Med. **235:** 789–791, Nov. 28, 1946.

Malignant lymphoma has been accepted as the designation of malignant tumors that are characterized by progressive enlargement of lymphoid tissue in various parts of the body. Pathological classification has been extensive and varied. Clinically the course is more or less rapidly fatal, with an average duration of life of two to three years. Some patients have survived for six years or more after surgical removal of the tumor. Cure has been assumed to depend on the extent, the location, and the pathological type of growth.

The records of 500 patients with malignant lymphoma treated by irradiation were reviewed and 15 cases meeting the following requirements were found—a single lesion at the time of treatment (which consisted primarily in irradiation); biopsy diagnosis; five-year survival without disease. There were 5 males and 10 females in this group; the youngest patient was ten years old, the oldest fifty-eight years. Abdominal lesions were found in 4 cases (in the mesenteric lymph nodes and gastro-intestinal tract); the peripheral lymph nodes were involved in 5 cases, and the tonsils (2 cases), larynx, parotid gland, femur, and skin in the others.

Histologically, there were 2 stem-cell, 1 clasmato-

cytic, 6 lymphoblastic, 3 lymphocytic, and 1 Hodgkin's lymphoma, 1 Hodgkin's sarcoma, and 1 follicular lymphoma. The x-ray dosage was 1,000 r or less in 9 cases, between 1,000 r and 2,000 r in 4, and over 2,000 r in 2. Radium was administered in 1 case.

Location did not seem to influence the result. It is the accepted opinion that if the entire growth can be removed a cure will follow. Findings in this study confirm this, indicating that if adequate irradiation can be administered before spread occurs, the tumor will be controlled. The duration of life would seem to depend somewhat on the type of tumor, but the information gained in this study does not confirm this, possibly because of the small number of cases. Localization of a disease at the time of treatment is probably an essential factor in cure. JOHN B. MCANENY, M.D.

Therapy for Soft Tissue Sarcomas: An Experimental Study. M. E. Maun, F. C. Jewell, and W. F. Dunning. Surg., Gynec. & Obst. **83:** 653–656, November 1946.

The authors have attempted to evaluate the relative merits of radiation and surgical therapy in the management of soft-tissue sarcomas in rats. The sarcoma was in its 148th transplanted generation and the progression of tumor growth was thought to be 100 per cent predictable. Various plans of treatment were instituted and the results were carefully studied. All of the animals were studied for lymph node metastasis, lung metastasis, size of tumor, and survival period. All the untreated rats had lymph node and lung metastases. The results of the various forms of treatment as measured by survival time are as follows:

	Cures	Uncured Rats, Days Survived (Average)
Control or untreated rats	0	31
Local excision of tumor after 17 days	0	40
Local excision after 10 days' growth	0	40
Roentgen therapy: 1,000 r to tumor after 10 days' growth	0	39
Extremity amputated after 7 days' growth	50%	63
Roentgen therapy: 1,500 r locally after 7 days' growth	0	50
Amputation after 7 days plus 1500 r to tumor site and node-bearing area on 7th and 9th days	71%	61
Roentgen therapy (1500 r) only to tumor and node-bearing areas on the 7th, 9th, and 11th days	30%	67

Roentgen therapy employed in this study was localized over the tumor or lymph node areas, with the following factors: 100 kv., 15 ma., 4 mm. Al filter, and 25 cm. target-skin distance. The most effective therapy seems to be amputation plus roentgen therapy. It is noteworthy that roentgen therapy alone prolonged the rat's life ten days, as did local excision, and the authors feel that this is equivalent to one year of a man's life. The study is an interesting one and lends support to the use of combined surgical and roentgen therapy. It is difficult to say how far one may apply these principles in the management of sarcomas in man.

JAMES C. KATTERJOHN, M.D.

Treatment of Residual Lymphoid Tissue in the Nasopharynx by Radium. Leslie N. Gay. J. Allergy **17:** 348–351, November 1946.

This paper is part of a Symposium on Infectious Asthma. The author discusses the results obtained by Crowe and his associates with the application of radium in deafness due to excessive lymphoid tissue. The relation of infected tonsils and infected adenoids to bronchial asthma has long been recognized, and it was observed in Crowe's series that many of the children who were deaf for the higher tones also had bronchial asthma. Many of these children were allergic to the usual inhalants but had failed to respond either to desensitization or to removal of the allergen. They had recurring colds associated with asthmatic attacks, and numerous islands of infected lymphoid tissue were present in the nasopharynx. Following irradiation, the attacks diminished in severity and frequency and in some cases ceased to occur. This beneficial effect may have been due to reduction in secretion, to decrease in the absorption of allergic substances by nasal and nasopharyngeal tissue, or to removal of the nasopharyngeal "culture tube" in which sensitizing bacteria thrive.

The author believes that a child who has frequent winter colds and an associated asthmatic bronchitis derives dramatic relief from a properly spaced course of radium therapy. It is wise to complete the treatment during the summer, for then respiratory infections are not so prevalent and treatment is less likely to be interrupted. A child who is sensitive to some allergen may get disappointing results from the usual desensitization treatment because of the secondary infection in the residual lymph nodules. In this group, irradiation is also of great assistance. In conjunction with specific desensitization therapy, irradiation has completely relieved many of these patients of their disturbing symptoms.

[For a description of the radium applicator and the technic of treatment, the reader is referred to abstracts in Radiology: **44:** 318, 1945; **47:** 208, 1946.]

Evaluation of the Beta and Gamma Radiation Due to Extended Linear Sources of Radium. Robley D. Evans. J. Indust. Hyg. & Toxicol. **28:** 243–256, November 1946.

The author's summary covers the material of this paper so adequately that it is quoted in full:

"The beta and gamma radiation from extended linear sources of radium contained in a narrow radium-gold foil covered by 0.3 micron of gold and 1.0 micron of nickel, have been measured and the results correlated with theory. At distances of a few feet from the active surface, the ionization due to beta rays is about 100 times the ionization due to gamma rays.

"The proposed maximum permissible dosage level for beta radiation of 125 mrep. [milli-roentgen-equivalent-physical] per hour is found at distances of the order of 18 to 33 inches from unshielded sources of various lengths, each containing 25 micrograms of radium per linear inch. Isodose curves are given for both beta and gamma radiation.

"All the beta radiation can be absorbed by shields of 1/16 inch lead, or 1/8 inch of iron, or 3/4 inch of wood. Such shielding, so arranged as to also prevent beta rays from being scattered towards the operators, is desirable in industrial installations. If shielding is not feasible in particular installations, magnetic fields of the order of 2,000 gauss may be used to obtain about a ten-fold reduction in the beta ray intensity.

"If beta rays are excluded by shields, the residual gamma radiation equals the maximum permissible level of 12.5 mr. per hour at distances of the order of 5 to 9 inches from sources of various lengths, each containing 25 micrograms of radium per inch.

"The alpha radiation is confined to a local region, within about 3 inches from the radium source, and accounts for the major portion of the effectiveness of such sources in preventing the accumulation of static-electricity in various industrial operations. When radium is used as the parent radioactive substance of the alpha radiation, the unwanted emission of beta and gamma rays is unavoidable. Consideration might well be given to the commercial development of alpha ray sources which emit little or no beta or gamma rays, such as plutonium, protactinium, or polonium."

EFFECTS OF RADIATION

Effect of Irradiation on the Coagulation Time of the Blood in Normal Individuals. Vincenzo Masini. Radiologia (Rome) **2:** 393–403, 1945.

The author reports the effect of 200 r administered over the spleen, liver, lower abdomen or buttocks of normal individuals upon the coagulation time of the blood. As compared with the coagulation time taken before irradiation, such treatment produces a decrease in the coagulation time with little variation in the fibrinogen and in the platelets.

CESARE GIANTURCO, M.D.

Protective Action of Desoxycorticosterone Acetate Against X-Ray-Induced Liver Changes. Friedrich Ellinger. Science **104:** 502–503, Nov. 29, 1946.

In view of his studies on liver changes incident to irradiation (Radiology **44:** 241, 1945) and the accumulated evidence that the symptoms of radiation sickness are attributable to histamine-like substances, if not to histamine itself, the author conducted experiments to evaluate the protective action of desoxycorticosterone in irradiated mice. His studies revealed a marked reduction in the amount of sudanophilic fat in irradiated animals treated with desoxycorticosterone as compared with the untreated irradiated group. No striking difference in the radiation effects on the bone marrow or spleen was noted. Desoxycorticosterone was also found to have some protective action against the lethal effects of irradiation. SYDNEY F. THOMAS, M.D.

Action of Roentgen Rays on the Enzyme Catalase. Arne Forssberg. Acta radiol. **27:** 281–293, May 6, 1946.

The mode of action of roentgen rays on living organisms is discussed and the variation in sensitivity of the cells of different organs, tissues, and species is noted in relation to the conditions under which radiation is administered. To study the problem of whether the action of radiation is direct, "the hit theory," or indirect, a "radiochemical" action, the author has investigated the effect upon the enzyme catalase, using a solution of the purified crystalline substance. By varying the catalase concentration of the solution, the intensity of irradiation, and the gas concentration of the solution, results were obtained which indicate a complicated interaction of the irradiation products formed in the solvent with the enzyme, as well as some direct action upon the enzyme molecules. Results obtained when the enzyme solution was frozen seem to indicate that the reaction is predominantly in the immediate vicinity of the enzyme molecule. ELIZABETH A. CLARK, M.D.

Influence of Roentgen Rays on Isolated Cell Nuclei. Hans van Euler and L. Hahn. Acta radiol. **27:** 269–280 May 6, 1946.

Cell nuclei isolated from fresh calf thymus were irradiated with 25,000 r and 65,000 r to study the possible physiological change. Estimations of the phosphorus, nitrogen, desoxyribonucleic acid, and histone content were made to determine the effect upon chemical properties. Viscosity measurements, indicating the degree of polymerization, dialysis determinations for the molecular size of the proteins, and an adsorption analysis to determine the ratio of dissociable and dissociated nucleoprotein molecules to the total protein, were carried out in a study of the effect upon the physical properties. In none of the determinations was there significant difference between the irradiated nuclei and the control preparation. The author stresses, however, that these results do not indicate biological inactivity of the cell nuclei. ELIZABETH A. CLARK, M.D.

Essential Safeguards in Production and Use of Atomic Energy. John E. Wirth. Occup. Med. **2:** 428–438, November 1946. **Atomic Energy in Industry and Physical Sciences.** Samuel K. Allison. Ibid. pp. 439–446. **Physiologic Effects of Nuclear Energy.** Shields Warren. Ibid. pp. 447–451.

The three papers listed above constitute a symposium on Atomic Energy in Industry and Medicine, presented at the Seventh Annual Congress on Industrial Health, Boston, 1946. The titles indicate the scope of the papers. Each emphasizes the importance of protection. According to Wirth, essential safeguards in the production and use of atomic energy must be directed toward the working area and the surrounding community. They must encompass (1) personnel, by education and organization; (2) monitoring, by the personnel and by a separate health-physics unit stressing personnel monitoring, area surveys, research and developments; (3) equipment, such as personnel-monitoring and area survey instruments, barriers, ventilation, protective clothing, technics, and handling devices; (4) well trained laboratory personnel and special tests for analyzing human excreta for chemically and radioactively toxic elements. For details, the original papers should be consulted.